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## PERFORMANCE OF "NORTHWESTERN" TYPE LOCOMOTIVES.

### Chicago & Northwestern Railway.

### Built By The Schenectady Locomotive Works.

These locomotives, which have been described in the September and October issues of this journal, have given an excellent account of themselves in service. Both Mr. Quayle and Mr. Henderson speak in the highest terms of their performances. The writer received every courtesy from them in examining their operation on the road, and is convinced that this design is a decided step in the right direction. When a fireman of such large engines, on exceedingly hard runs, requiring at times the consumption of 9 tons of coal in three hours, voluntarily says that these engines are the "easiest he ever fired," the design may be accepted as successful. In firing, with ordinary care, there is no black smoke from the stack, and very few sparks. The strongest exhaust does not tear the fire, and the steaming qualities with "run of mine" Illinois coal are perfectly satisfactory. The writer saw one of these engines start a heavy train of about 450 tons, and, with the reverse lever in full gear, force it to a speed of 40 miles per hour without tearing the fire or running the steam pressure down. He also saw one of them haul a heavy train 32 miles in one hour, making six stops, the running cut-off being half stroke, with the safety valve blowing at intervals all of the way. The ability to sustain the power is remarkable, and the engines are continually surprising the men who run them.

Engine No. 1,017, the one which made the record on the New York Central, published last month, was given a very severe trial on the "Colorado Special" train No. 5 on the Chicago & Northwestern, October 16. This train leaves Wells street station, Chicago, at 10 a. m., and is due at Clinton, Ia., 138 miles at 1.20 p.m. The regular train has seven cars, a mail car, a buffet car, sleeping car, dining car, chair car and two passenger cars. On the trip in question, however, there were three extra passenger and one chair car added, for the purpose of ascertaining the capacity of the engine in maintaining high continuous horse-power.

The grade of the road is shown by the profile, which is reproduced. The regular schedule shows eight station stops, but in addition to this, there is the draw-bridge at the Mississippi River and the C., B. & Q. Railroad crossing between the river and Clinton station. In addition to this the train was compelled to stop at another station on account of meeting another passenger train stopping at the station, so that on the day in question the run was made with eleven actual stops between the terminals of the division; partly due to this and other causes, the train at one point was as much as seven or eight minutes behind schedule time, but as will be seen on the diagram, reached Clinton one minute ahead of time.

The profile is seen to be a continuous rise up to Malta, which is about one-half way over the division, from which point there is a general descent with a number of short up grades. As the run was not intended to be one demonstrating "fuel economy" but to illustrate the capacity of the engine, the efforts were made to keep the engine up to the maximum at practically the whole distance, and, as might be expected, the fuel consumption of nine tons for this trip was rather large. This is accounted for by the fact that the locomotive worked on an average of 10 ins. cut-off over the entire division, and the average horse-power was between eleven and thirteen hundred for almost the entire trip. The maximum horse-power was reached on practically level track, and shown by diagram No. 18 to be 1,507. For this card the speed was 50 miles an hour and the cut-off 12 ins. Between Ashton and Nachusa a speed of from 60 to 70 miles was maintained with a cut-off averaging 10 ins. and a horse power of nearly 1,300. It should be stated that these diagrams were taken during the ordinary operation of the engine on its trip and that there was no pretense made of dropping the lever to obtain any particular diagrams, and that these conditions were maintained continually, as far as possible, throughout the trip.

One injector (a No. 19 Monitor) was kept at work continually, and a greater part of the time the second injector was used to about one-half its capacity. The statement of nine tons of coal for the trip is probably not entirely correct, but will give a fair idea of the economy of the engine as a prime mover. Allowing 1,250 indicated horse-power as an average on the trip of three and one-third hours' duration, the consumption of coal was 4.3 lbs. per indicated horse-power per hour, which is very fair for a locomotive worked as severely as this one was on the run in question. It will be noticed by the diagrams that there was no great difficulty in keeping up steam, although it goes without saying that to handle that amount of coal in the time mentioned, the fireman was kept busy.

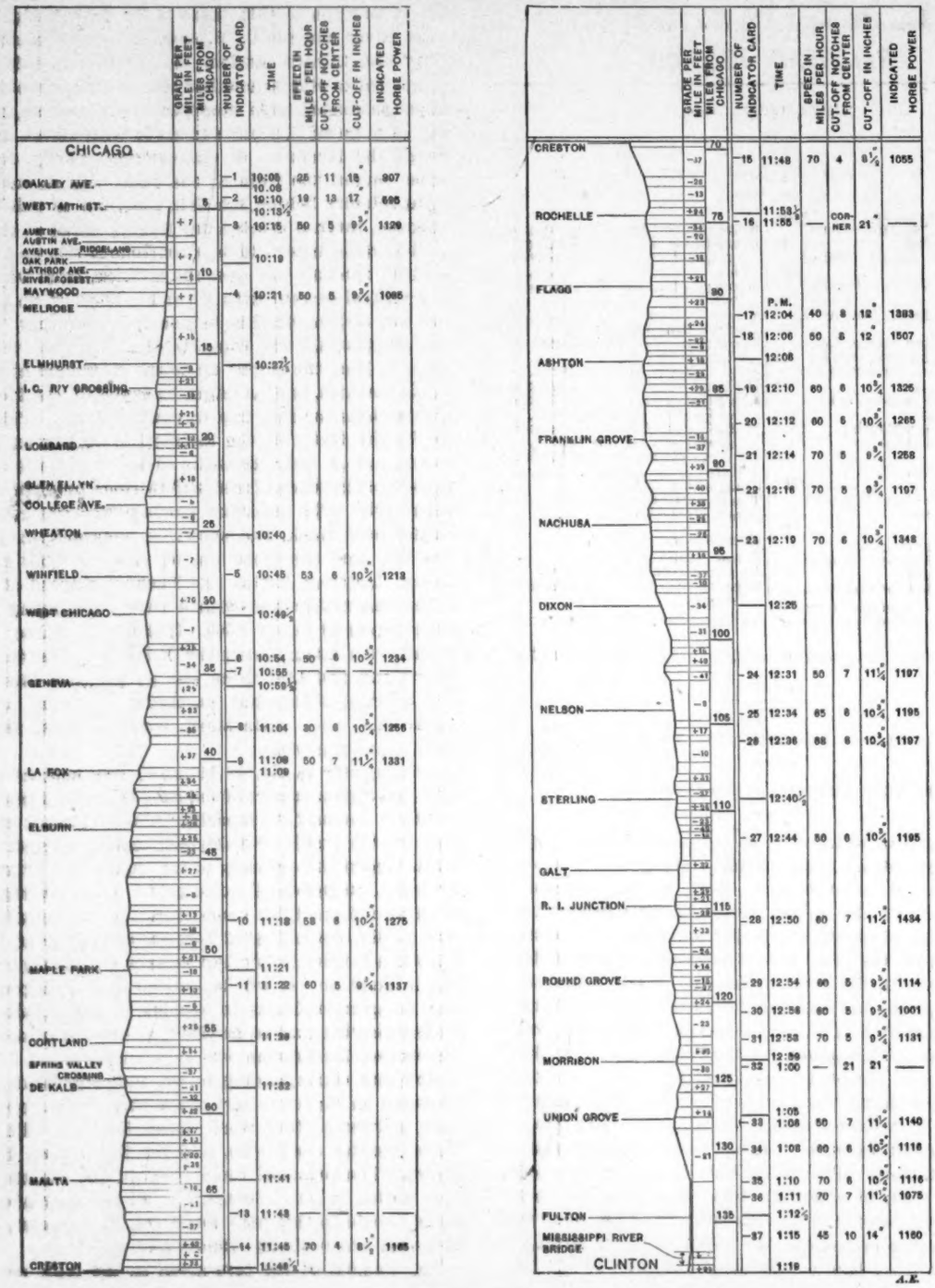
Numbers corresponding to the indicator cards, that are not produced on the lower part of the sheet, indicate that they have been omitted as they were almost identical with others taken under similar conditions, and for this reason have not been drawn. The principal dimensions of the engine have already been stated in our columns, but we can now add that the exhaust nozzle in this case was 5 ins. in diameter, and that the fuel used was ordinary Illinois coal.

The weights of the cars given in the table are those taken empty, so that considering the baggage, mail and the passengers there would be about 450 tons back of the tender. If five minutes are allowed for each stop, which is pretty close to the time lost in making the stop and regaining a high speed afterward, it will be seen that the average running time of this train was 55 miles an hour between stations, and the speeds given at the time the diagrams were taken show that this was maintained on an average, and often exceeded, throughout the trip.

These figures for horse-power may have been exceeded in locomotive practice, but for long-sustained power we have no record as good as this for a soft coal burning engine, and in such severe service. It is a remarkable performance.

The cards exhibited in the three series, A, B and C, on page 336, were taken on this run, but with an ordinary train. Series A represents the effect upon the horse-power of increasing

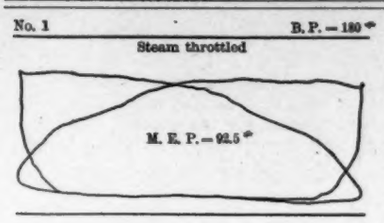
**Profile of the C. & N. W. Railway.—Chicago to Clinton.**

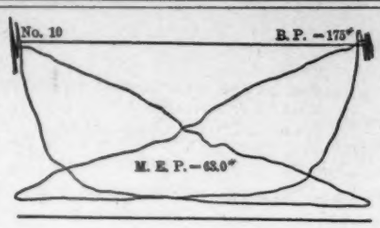


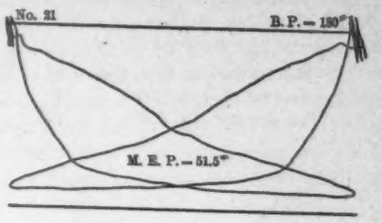

**Performance of "Northwestern" Type Locomotives—Chicago & Northwestern Railway.**
**Record Showing Sustained High Horse-Power for a Run of 138 Miles.**

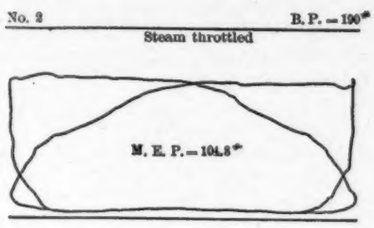
the cut-off without varying the speed, which, in this case, was 50 miles per hour. It will be seen that the horse-power increased from 784 to 1,063 with essentially the same boiler pressure and the throttle wide open. The reverse lever was moved to increase the cut-off by 1 in. at a time. Series B carried out the same plan but with a less uniform speed, the cut-off varying from 8⅛ to 11¾ ins., and the horse-power from 1,007 to 1,296. In series C, showing three cards taken at three-minute intervals, the speed rose from 48 to 70 miles per hour. The last card was taken at 11¾-in. cut-off and at 70 miles per hour. This power was sustained about 10 minutes, but the fireman believed that he could have kept it up for the entire trip without exceeding his own capacity or that of the boiler. This train weighed about 350 tons and made the 10 stops already referred to, doing the 138 miles in 3 hours and 25 minutes.

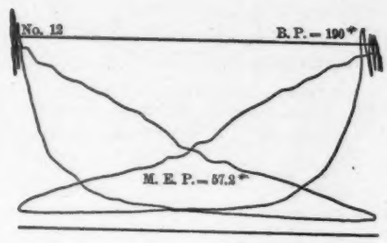
This engine also rides remarkably well. There was no rolling and very little jerky motion. How much of this is due to the outside journals on the trailing wheels and how much to the long leaf springs over the trailer boxes we do not know, but it has been demonstrated that easy riding may be obtained, and it is certainly worth a great deal of trouble to secure this result, even if it is at the expense of some additional weight and complication.

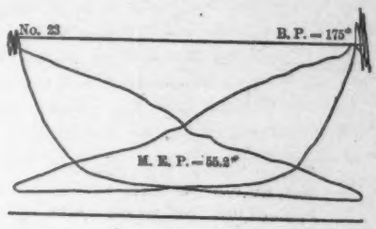


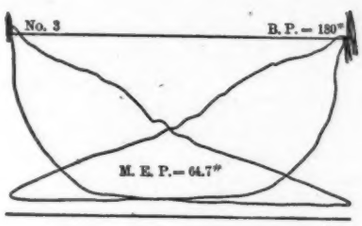



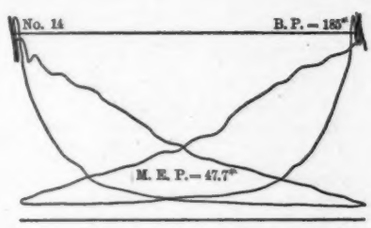



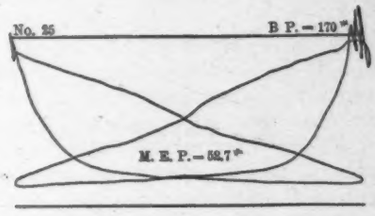



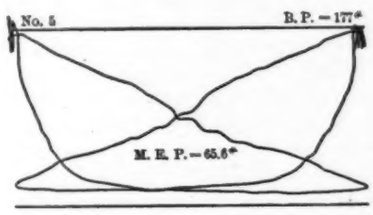



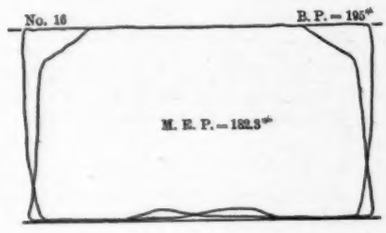



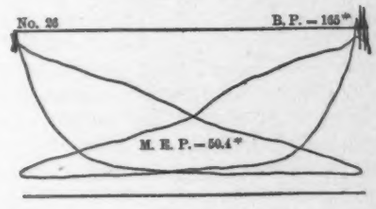



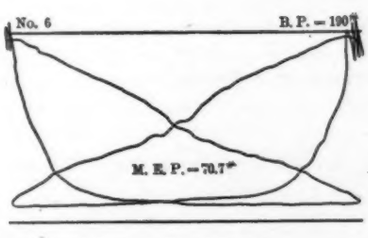



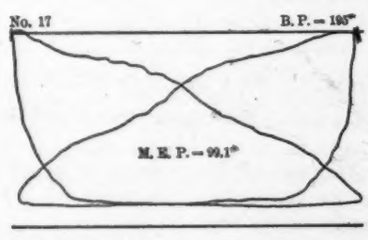



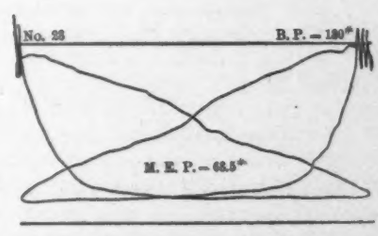



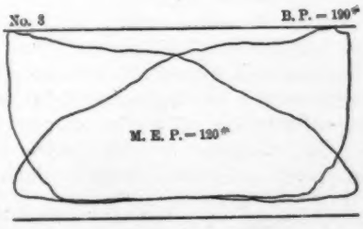



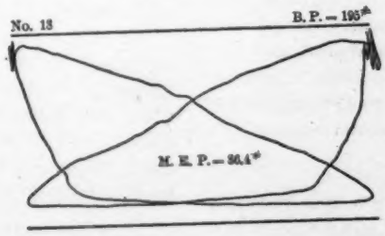



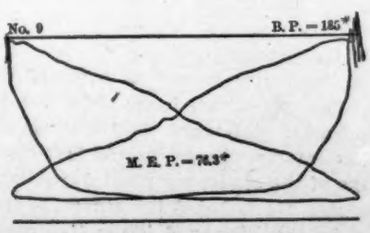



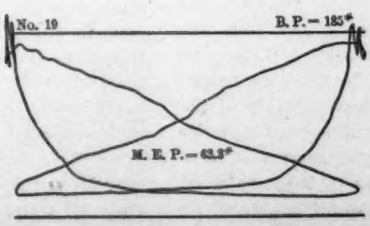




Note: All cards but No's. 1 and 2 were taken with throttle wide open.
Scale 1 inch—120 pounds.

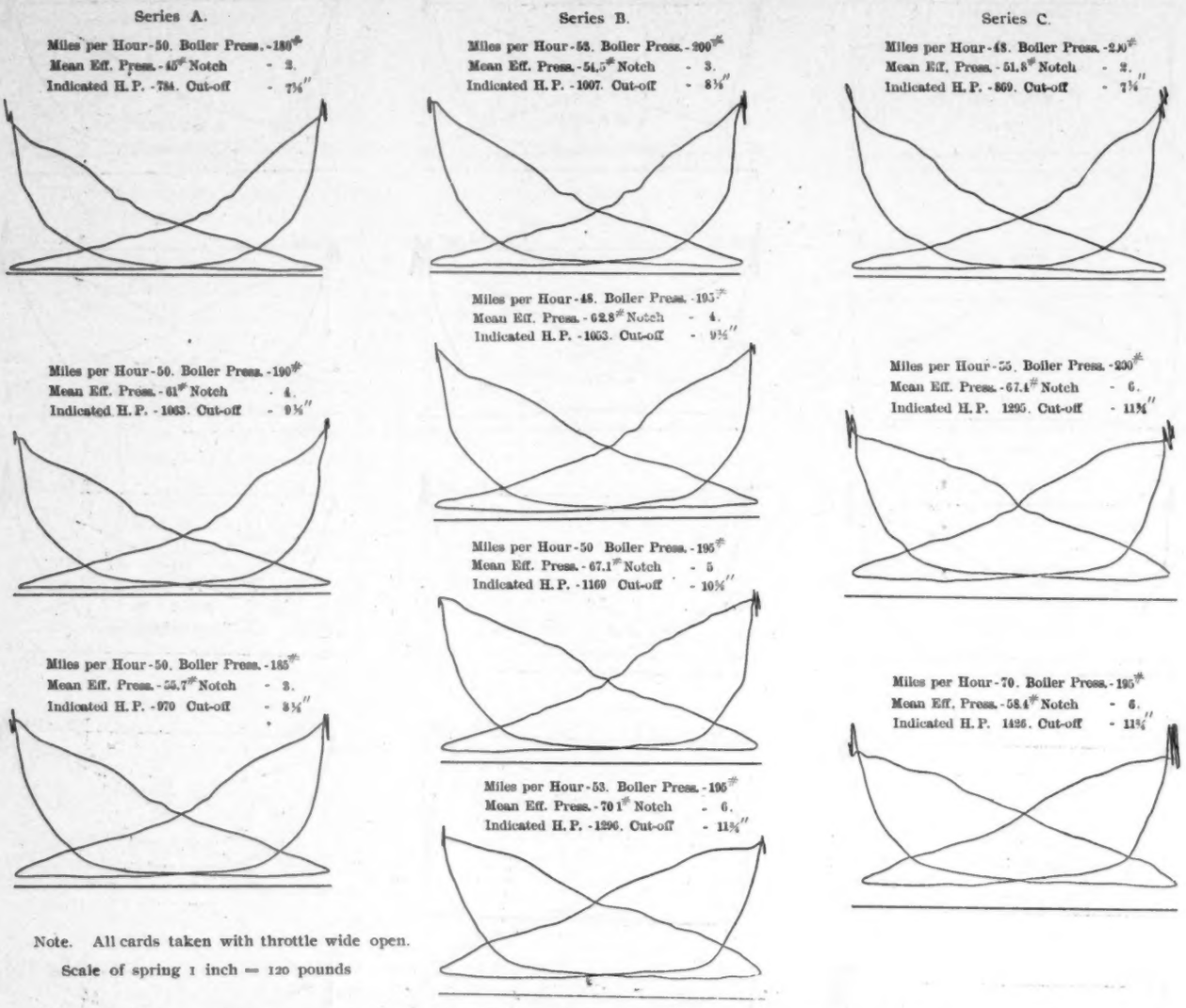
| Composition of Train. | |
|---|---|
| Style of Car | Weight. (tons) |
| Mail | 32 |
| Sleeper "Marcellus" | 62 |
| Dining | 48 |
| Chair | 36 |
| Passenger | 37½ |
| Passenger | 37½ |
| Passenger | 37½ |
| Passenger | 37½ |
| Chair | 37 |
| Passenger | 29 |
| Buffet | 48 |
| Total | 442 |




**Performance of "Northwestern" Type Locomotives—Chicago & Northwestern Railway.**

**Indicator Cards Corresponding with Record on Page 334.**


Series A.
Miles per Hour-50. Boiler Press.-180#
Mean Eff. Press.-45# Notch - 3.
Indicated H.P.-784. Cut-off - 7⅜"
Series B.
Miles per Hour-53. Boiler Press.-200#
Mean Eff. Press.-54.5# Notch - 3.
Indicated H.P.-1007. Cut-off - 8⅛"
Series C.
Miles per Hour-48. Boiler Press.-200#
Mean Eff. Press.-51.8# Notch - 2.
Indicated H.P.-869. Cut-off - 7¼"
Miles per Hour-48. Boiler Press.-195#
Mean Eff. Press.-62.8# Notch - 4.
Indicated H.P.-1053. Cut-off - 9½"
Miles per Hour-50. Boiler Press.-190#
Mean Eff. Press.-61# Notch - 4.
Indicated H.P.-1063. Cut-off - 9⅛"
Miles per Hour-55. Boiler Press.-200#
Mean Eff. Press.-67.4# Notch - 6.
Indicated H.P. 1295. Cut-off - 11¾"
Miles per Hour-50 Boiler Press.-195#
Mean Eff. Press.-67.1# Notch - 5
Indicated H.P.-1169 Cut-off - 10⅝"
Miles per Hour-50. Boiler Press.-185#
Mean Eff. Press.-55.7# Notch - 3.
Indicated H.P.-970 Cut-off - 8⅛"
Miles per Hour-70. Boiler Press.-195#
Mean Eff. Press.-58.4# Notch - 6.
Indicated H.P. 1426. Cut-off - 11¾"
Miles per Hour-53. Boiler Press.-195#
Mean Eff. Press.-70.1# Notch - 6.
Indicated H.P.-1296. Cut-off - 11¾"
Note. All cards taken with throttle wide open.
Scale of spring 1 inch = 120 pounds

**Performance of "Northwestern" Type Locomotive—Chicago & Northwestern Railway.**

**Cards Showing Variation of Power and Speed.**

The performance sheets show a decided advantage of the wide firebox combined with piston valves and an able boiler, the records of these engines being approximately 20 per cent. better than those of the heavy 8-wheel engines on this road. The fire does not move with the heaviest exhausts, run-of-mine coal is satisfactorily used with very little smoke and few sparks, the two fire doors seem to please the fireman, and the entire design has thus far proved to be all that was expected or desired by the operating as well as the motive power officers.

Steel rails of the prevailing large sections are well known to be inferior in wearing qualities to those of lighter section of some years ago. Captain R. W. Hunt, in his paper before the American Society of Civil Engineers, reminds us that the heavier sections receive less work in the rolls and they are also finished at a higher temperature than smaller sections. In his judgment it is desirable to give the rail its finishing passes after it has cooled slightly. Captain Hunt speaks highly of the McKenna process of re-rolling old rails. Re-rolled rails promise to give better wear than new ones of heavier sections. Five years' experience and the use of 100,000 tons of these rails on large roads supported this opinion. "One chief engineer, on whose road there are many of these rails, says: 'No rail ought to be used at all until after it has been renewed.'" The most desirable effect secured by this process is that produced by finishing the rolling at low temperatures.

Coal consumption for gas engines operating with producer gas is stated in a series of articles in "Engineering" to be from 1.1 to 1.6 lbs. (anthracite) per brake horse-power. In 12 plants, including 28 gas engines aggregating 2,905 horse-power, the figures fell within the limits stated. Another group of 10 engines operating with producer gas and aggregating 824 indicated horse-power consumed 1.16 lbs. of anthracite per indicated horse-power hour, and in another case 9 engines averaged 1.27 lbs. of anthracite per brake hourse-power per hour.

In an interesting comparison of the economy of stationary and locomotive steam plants the "Railroad Gazette" shows, when one of each type of about 1,000 horse-power are considered, that the locomotive stands remarkably well. Of course the advantage in fuel economy per unit of work is with the stationary plant. A locomotive cannot be expected to do much better than 4 to 7 lbs. of coal per horse-power per hour, while a simple non-condensing stationary plant will use about 3 or 5 lbs. But when the interest charges on the first cost are considered the advantage of the stationary plant dwindles, and when all sources of expense are included the difference in the cost of power delivered by the compound locomotive used by a triple-expansion condensing engine is surprisingly small.

## WHAT MOTIVE POWER OFFICERS CONSIDER IMPORTANT.

### As Indicated in a Number of Interviews.

When given the opportunity men usually indicate the direction of their thought by the subjects they like to talk about. The following paragraphs reflect for our readers the impressions gained by our representative in recent interviews with a dozen of the most progressive motive power officers by the subjects which they voluntarily introduced.

Without doubt firebox design is now the leading subject with motive power men. Wide fireboxes for soft coal burning engines are coming into use very rapidly, and judging from the number of them springing up in all directions the change may appear to be sudden. It really is not so, for the necessity for the change was appreciated long ago, and it only remained for the movement to start in order to become general. The good work has as yet only begun, and it is now necessary to find the proper size of grates for the special condition existing on each road. We shall soon see the grate made to fit the coal, but this question is secondary in importance to that of the initial step of getting the mud rings out beyond the frames and it will need to be carefully studied for each individual case. From recent developments it is clear that grate areas should not be proportioned to heating surface or to cylinder volume, but that they should be made to suit the coal and the demands made upon the fire. An appropriate illustration of this proved that coal may be too good, or that a firebox designed for low grade or slack coal is not the thing for high grade lump. Several invited guests were to watch the performance of one of the newest wide firebox engines designed to burn slack. The designer of the engine discovered to his dismay that the engine had accidentally received a tank of the best of soft coal in large lumps for the exhibition run and even with the most skillful handling the steam at once ran down to 100 lbs. However, at the bottom of the pile was a lot of slack which had been left on the tender from the previous run, and when this was reached the engine steamed beautifully, retrieving the reputations of all concerned. The grate was twice too large for the lump coal and even when it was broken up the steam failed. Grates should be large enough to burn enough of the poorest coal to make steam for the hardest work of the engine, and if it is occasionally necessary to burn better or different coal the area should be adjusted by blocking off a portion of the grates. This applies to hard as well as soft coal. The combustion space thus provided at the front end of the firebox is the best kind of combustion chamber and the space is generally more necessary with the better qualities of fuel than with the cheaper grades. It will probably be found necessary to provide for this adjustment in the design of grates.

Larger tenders are the rule on a number of roads. The Lehigh Valley has adopted 7,000 gallon tanks for freight engines and 6,000 for passenger. In seeking the reasons we are told that greater capacity in tenders is "everybody's game," in the sense that there are no objections. They would naturally increase in size to keep pace with the locomotive, but there are other reasons, in the reduction in the number of stops for water, the desire in many cases to avoid taking water from certain undesirable sources and the saving of the general destruction wrought by the savage emergency brake applications which seem to be necessary in order to stop trains so that the manhole of the tank is opposite the water column. In freight service, tank stops are particularly destructive, often causing trains to break in two. The sudden shocks due to the emergency applications of the brakes in order to stop at the right spot are also severe upon the draft rigging which is not actually broken. When traffic is heavy enough the track tank gives the ideal method of taking water, but these are not sufficiently common to avoid the necessity for large tenders. The desire to aid the fireman by an intelligent arrangement of sloping sides of coal spaces is noticeable. Many recent designs have carried this feature farther than was customary a year or so ago. Sloping sides are not new, but of late the slant and position of the slopes have been greatly improved so that the coal will be sure to slide and save a few steps. Unless these matters are carefully attended to, firemen are justified in protesting against the tendency toward very large engines.

The whole question of water service for locomotives is opened up by the enlargement of tenders and a most important improvement in the delivering capacity of stand-pipes and tank cranes is seen to be necessary. It is time to consider the general introduction of 12-in. pipes with cranes and stand-pipes of corresponding capacity. The Chicago & Alton, Chicago & Northwestern and other lines in the Middle West show their appreciation of quick delivery of water, but many roads exhibit a strange neglect of this. The writer watched the painful process of taking water on one very fine train for eleven minutes, and the train was late, when one minute is enough where the facilities are what they should be. These delays contribute to the necessity for heavier engines and motive power men should see to it that this fact is understood. In their own defence they should take it up and vigorously.

Boiler design with a view of meeting the requirements of high steam pressures and the evident tendency to increase them is looked upon with not a little concern by those who have given most attention to the study of staybolt breakages. During the last few years the shapes of fireboxes have been greatly improved in the direction of avoiding sudden changes of curvature of the side sheets. This is true of narrow as well as wide fireboxes, and it is now customary to give easy and uniform curvature to the side sheets of wide fireboxes and to make the enlargements from the water legs of narrow fireboxes as gradual as possible. These changes of form have proven their desirability, but something more seems to be needed. One of the possibilities of the future is the use of specially prepared copper as a material for staybolts. Copper has been "treated" to give it a tensile strength between 45,000 and 50,000 lbs., and if its ability to withstand frequent bendings is not impaired it may again become a factor in boiler construction. We hope to give our readers information on this subject after seeing the results of promised developments.

Water pipes for cooling locomotive and tender bearings have been abolished on the Lehigh Valley, and without an increase of the number of delays due to hot boxes. These pipes were originally applied for the purpose of cooling hot bearings while trains were standing at stations, but the enginemen soon extended their use and continued the streams of water while running, until the number of cut journals became troublesome. The water was so easily turned on as to tempt the men to use it too freely, and in a way not intended and to neglect the proper methods of lubrication. When the pipes were taken off no new devices were put on, but the bearings were merely kept in good condition, the inspection was made more severe and special care was taken to maintain the waste in the cellars and boxes, so that it would properly fulfil its functions. It is interesting to know that the remedy for hot bearings is so simple.

Methods of handling work in erecting shops have changed in a number of shops visited. Formerly an erecting gang of four or five men and a foreman did all of the work on a certain number of engines. They stripped the engine upon its arrival in the shop, distributed the parts for cleaning and repairs, reassembled them and finally put them together on the engine. Now the stripping and all work not requiring attention from machinists and relatively high-priced men is done by a stripping gang who take down, distribute, and finally asemble the parts for replacement. These men work under a foreman, and they relieve the regular erecting gangs of all the work which may be entrusted to relatively unskilled labor. The effect upon the men is to develop a rather unexpected amount of intelligence among them which seems likely to lead to a

recruiting source for the erecting gangs. In the new shops of the Buffalo, Rochester & Pittsburgh Mr. Turner expects to use two such gangs, and they will be essentially "crane gangs," the foreman being in charge of the cranes. There they will also raise engines to take out and replace driving wheels and trucks. The foreman will be expected to keep track of the location of every part removed from each engine he works on and in this way he will be a valuable assistant to the general foreman.

How to improve the passenger-car truck is one of the questions of the day. It can not be taken up too quickly or too thoroughly in view of the present tendency toward increasing the weight of passenger cars. A weight of 125,000 lbs. in a new Pullman car is not at all encouraging to those who are doing their utmost to furnish power enough to keep fast trains up to schedule. This weight question is becoming serious, and such an increase for which there can be no justification will probably call out the most vigorous of protests not only from mechanical officers, but general managers as well. A material saving of weight may be secured by improved truck design, and the truck is an excellent beginning for a study of the elimination of unnecessary weight in passenger equipment. Those who are working on this problem realize the influence of great weight of cars upon smooth riding, and they are beginning to examine the possibilities of securing the same result by improved spring suspension. We notice a tendency to question the value of the equalizer in the construction of four-wheel trucks, and it will not be surprising if a design of truck of this type should appear under a heavy car, with 5 by 9-in. journals, and elliptic springs over the journal boxes. As at present constructed the coil springs over equalizers are extremely short, and they are placed quite a distance from the journals. This does not seem to be a favorable arrangement for smooth running, and it brings up the question whether the equalizer is necessary on the smooth tracks of the present day. Doubts of this are expressed by men who are in a position to demonstrate the facts, and there is good reason to expect interesting developments. It is important to know whether the smooth-riding qualities of the heavy Pullman car cannot be obtained in a combination of a lighter car and improved spring rigging. In a list of Pullman cars on the Burlington road there are five weighing 124,000 lbs. each and four weighing 120,000 lbs. each. Other roads have, perhaps, as many. What this means will be clearly understood if these nine cars should happen to be put in the same train. It would weigh 550 tons behind the tender, without baggage, mail or express cars. These weights have apparently increased to the extent mentioned without having attracted much attention.

(To be continued.)

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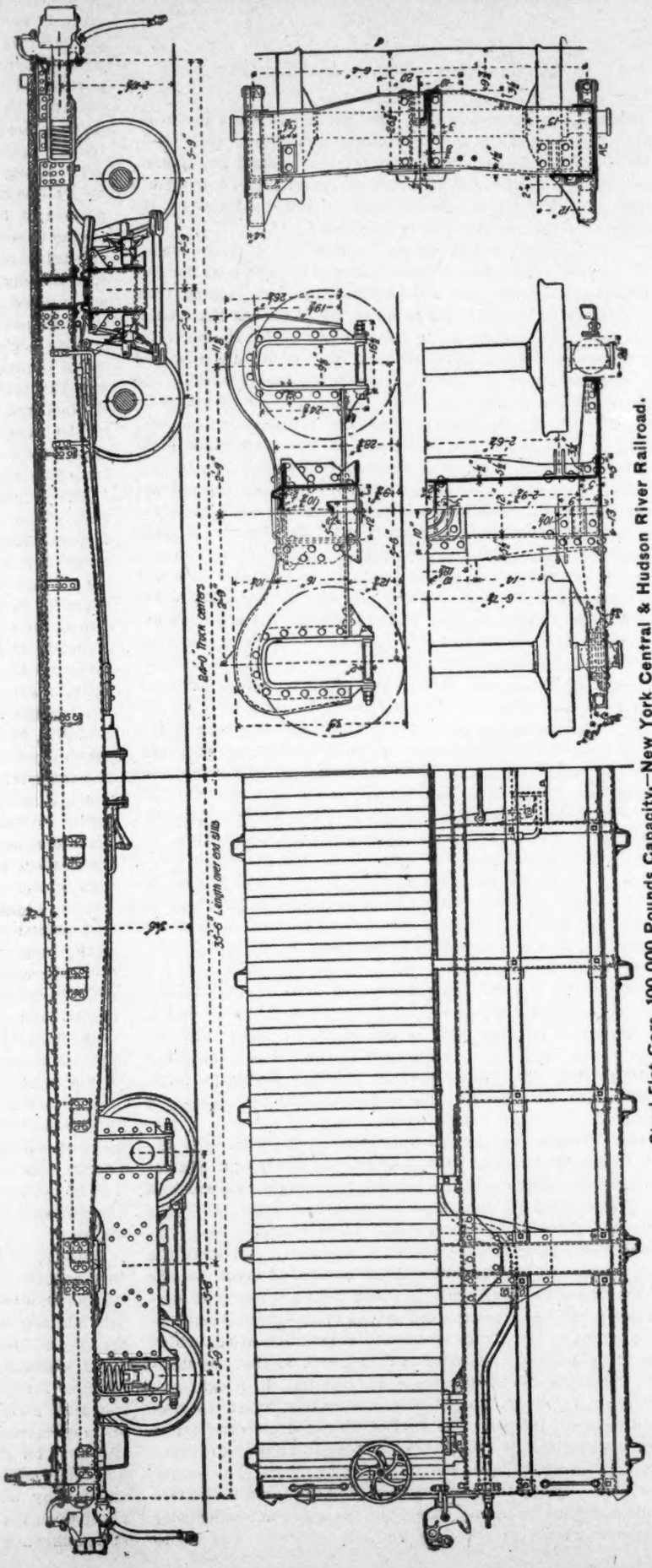
The Lake Shore & Michigan Southern has ordered 80 steel ballast cars of 100,000 pounds capacity from the Pressed Steel Car Co.




Steel Flat Cars, 100,000 Pounds Capacity.—New York Central & Hudson River Railroad.
Built by The Pressed Steel Car Company.

## STEEL FLAT CARS, 100,000 POUNDS CAPACITY.

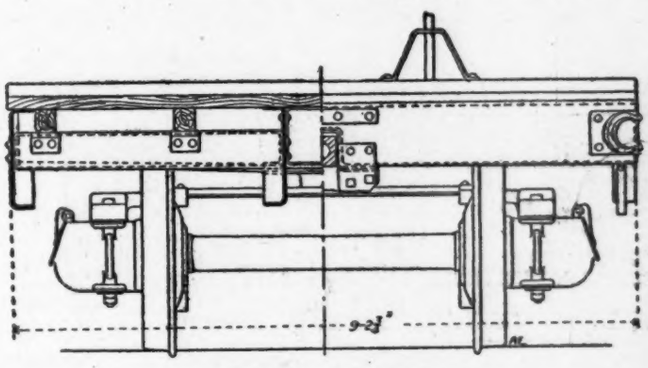
New York Central & Hudson River Railroad.

Pressed Steel Car Company, Builders.

This road has found flat cars of 50 tons capacity very convenient in shipping heavy machinery, narrow-gauge locomotives and other heavy objects which cannot be conveniently loaded into box or gondola cars. About two years ago 10 steel cars were built and the demand for them has necessitated the building of 10 more of this capacity. The accompanying engravings illustrate the construction and indicate the design of the underframing and the manner of securing the wooden decking. The cars were built by the Pressed Steel Car Company, using pressed steel parts exclusively, except for the plank deck and stringers. They were built to the following general dimensions:

| | |
|---|---|
| Length over end sills | 35 ft. 6 in. |
| Width over stake pockets | 10 ft. |
| Width over side sills | 9 ft. 2¾ in. |
| Width over wooden floor | 9 ft. 4¾ in. |
| Height, top of rail to floor | 3 ft. 8¼ in. |
| Height over brake shaft | 6 ft. 3 in. |
| Height to tops of center channels | 3 ft. 6 in. |
| Height to bottom faces of center channels at bolster | 2 ft. 8 in. |
| Distance between truck centers | 24 ft. |
| Trucks, wheel base | 5 ft. 6 in. |
| Trucks, centers of journals | 6 ft. 4 in. |

Four longitudinal pressed-steel channels carry the load. These are 10 ins. deep at the ends and from the inside faces



Half Section and End View.

of the body bolsters they begin to deepen, reaching a depth of 17 ins. for a length of about 7 ft. at the center. The outside sills are continuous and the center sills are cut at the body bolsters to let those members through. The cross members are pressed-steel channels 7 ins. deep and 4 ft. long secured between the webs of the center and side sills. There are 12 of these members, upon the upper flanges of which six oak stringers are carried. These extend the full length of the car; the outside and intermediate stringers are 3½ by 4 ins. and the two at the center at 3½ by 2 9/16 ins. The decking, which is of 2¼-in. oak, is secured by spiking to these. The construction of the bolsters and end sills is clearly indicated in the engravings.

The cars have Fox pressed-steel tracks, 33-in. wheels weighing 650 lbs. each and open-hearth steel axles with 5 by 9-in. burnished journals. Eight-inch double coil springs are used in the trucks, which are equipped with McCord journal boxes, Harrison dust guards and National hollow brake beams. The draft gear is attached to the webs of the large center channels. It has two twin springs and 21¾-in. follower plates at each end. The cars are fitted with Gould couplers and spring buffers. They weigh, empty, 28,400 lbs., this being the average weight of 8 cars.

We are indebted to Mr. A. M. Waitt, Superintendent of Motive Power, for the drawings from which our engravings were prepared.

## HARD, TOUGH STEEL BEST FOR RAILS.

P. H. Dudley has put his long experience in connection with steel rail practice into an elaborate paper read before the International Railway Congress. The principles elucidated by track inspection covering a number of years had been reduced to practice in the form of hard steel and stiff rail sections. These, the author says, have reduced the resistance of trains one-half since 1880, and the advantage is shown in the fact that one locomotive has drawn a train of 16 cars weighing 1,840,000 lbs. at a speed of 60 miles per hour. Soft steel would never have permitted such progress. The study of rails had reached a point permitting the design of rails for certain requirements as definitely as that of the design of locomotives of a stated capacity. The researches of this authority are summarized in the following conclusions, which are quoted from the paper:

As the permanent way becomes physically weak for the increasing traffic, more labor must be employed in its care and repairs to the equipment.

When the permanent way is made physically strong by stiff and smooth rails, less labor is required for its care and repairs to the equipment, and all the operating and maintenance expenses decrease.

When stiff and heavy rails are used, unless made of a high grade steel and proper width of head, the loss of metal will be faster for a given traffic than on weak and light rails.

On stiff rails the deflections in distributing the wheel load to the ties are much less, the area of contact between wheel and rail is reduced, therefore the intensity of pressure is greater per square inch of contact than on the lighter rails. The intensity of pressure of the wheel loads transferred to the ties, ballast and roadbed is reduced and this is the main economic feature of heavy rails.

The stiff rails in distributing the wheel loads over a larger area of roadbed increase the stability of the track, save labor, ties and roadbed by transferring from them the destructive work to the metal of the rail head, for which provision can be made. This will now require attention and study by the railroad companies. Too little care has been given to this important matter in the past, and as the traffic has increased and the heavier sections been introduced they have entirely changed the economic relations of the wear and deterioration of the permanent way.

The injury to the ties and road bed has been so much reduced by the heavy rails that ties properly treated could be introduced and used with economic results in the United States.

Close attention is paid to the number of miles locomotive and passenger coach axles are permitted to run, but hardly a thought has been given to the limitations of the life of rails due to the repetitions of stresses which take place in the metal of the rails due to the wheel loads of the passing trains. This feature will have as much to do with the limitation of the life of the rails as the question of the wear of the head of the rail.

We cannot expect a return to lighter loads and slower speeds of trains. These are likely to increase. As a measure of safety it is well that the rails do wear rapidly, as that insures removal before they get extremely dangerous as girders.

The principle that the equipment and permanent way form a single means of transport is now established, and that each one should be designed for the other.

In all of this work certain principles must be followed, adapting the construction to the conditions of service. For final economical results the main dependence must be in a broad sense on "hard" tough steel which is the proper "nature of the metal for rails."

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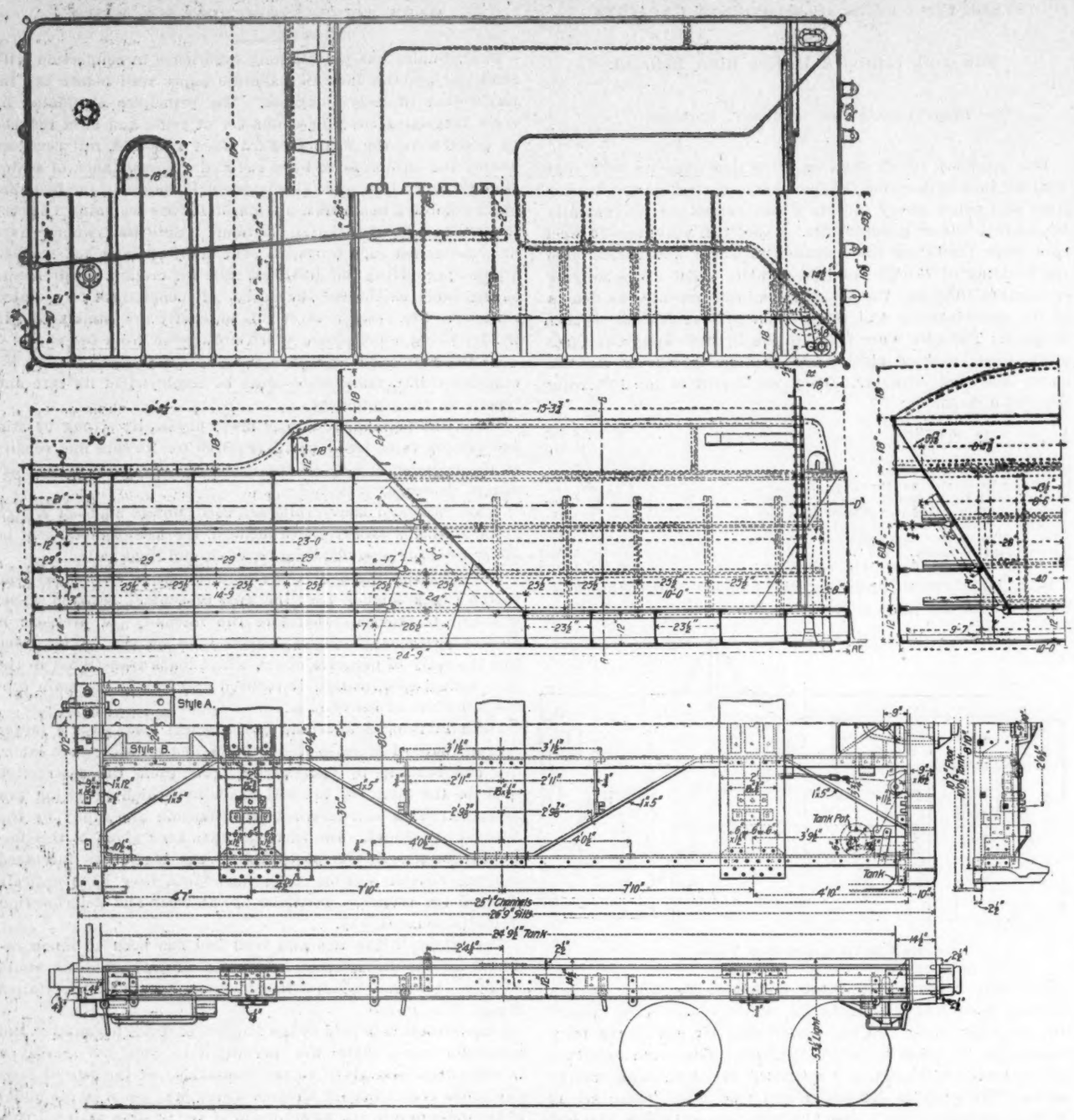
A remarkable hydraulic bending machine, capable of bending plates 4 ins. thick without heating, is in use at the Cramp shipyards in Philadelphia.




Large Tenders—Illinois Central Railroad.
Cistern and Tender Frame.

## LARGE TENDERS.

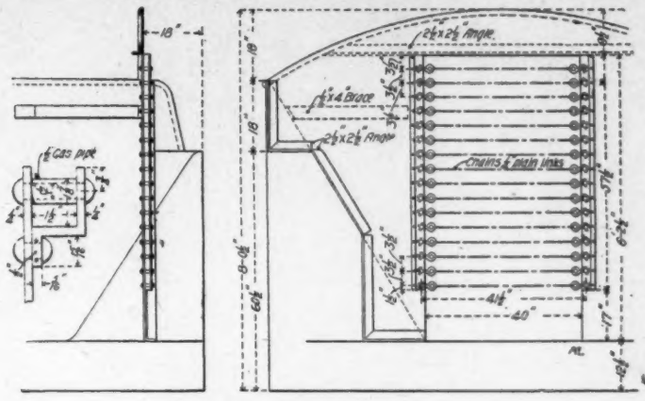
### Illinois Central Railroad.

### 7,000 Gallons Water and 18 Tons Coal.

In the article by Mr. William Forsyth in our June number describing recent practice in locomotive tenders the largest tank capacity shown was for 6,000 gallons. By courtesy of Mr. William Renshaw and Mr. W. H. V. Rosing of the Illinois Central we have received drawings of a 7,000-gallon tender designed by them for use with large engines on that road.

This tank is a combination of the V shape, with sloping sides and ends of the coal space and the water space under the whole of the coal space. The total length of the tank is 24 ft. 9 ins., the height of the rear portion is 5 ft., the total height over end boards 8 ft., and that of the water space under the flat portion of the coal deck is 12 ins. The width of the tank is 10 ft. The engraving presents a clear idea of the bracing of the large flat areas, the cellular structure under the flat deck and the bulkhead bracing of the body of the tank which is supplemented by rods and angles. The coal space has a segmental back board 18 ins. high, behind which is a large tool box. The manhole opening is 18 by 36 ins. In the actual construction a slight change was made in the angles, at the junctions of the slopes and the coal deck, but the engraving showing this was unfortunately delayed.

With large engines it is important to aid the fireman as much as possible by bringing the coal down within easy reach. In this tender the back and sides of the coal space converge to send the coal down to a flat deck 10 ft. long by 40 ins. wide. These sloping surfaces extend from the top edges of the coal sides down to this narrow deck without any perpendicular sur-




End Views, Showing Chain Gate.

faces. About 60 per cent. of the coal is expected to slide down to the flat deck.

The coal gate is novel. The front of the coal space terminates at a plate bulkhead with an opening 40 ins. wide. Across this opening 16 chains of ¼-in. iron and plain links form the coal gate. They are hung on pins at each end by hooks of ½-in. round iron. The chains hang 3¼ ins. between centers and the gate is neat, light, convenient and durable. Over the top of the gate in front is a front end board carried to the same height as the one at the rear. It is obvious that these chains permit of breaking lumps of coal at the front end of the load without opening the gate, which is an important advantage of this form of gate.

The drawing of the frame illustrates its construction sufficiently to make it clear without explanation. These tenders have Fox trucks with floating bolsters and they are equipped with the Westinghouse friction draft gear. They weigh 147,000 lbs. when loaded with 7,000 gals. of water and 16 tons of coal. The light weignt is 57,500 lbs.

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The Brotherhood of Locomotive Firemen has appropriated $9,000 as a nucleus for the erection of a home for aged, crippled and invalided trainmen. If other organizations of railroad employees connected with train service follow this example it will be possible to carry out the project. While the work done so far is entirely preliminary, the general plan for the establishment of the institution has been well worked out and the present intention is to locate it somewhere in the central West.

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"Why has the swing-beam truck so largely been abandoned from freight service?" was the subject discussed at the October meeting of the New York Railroad Club. The three reasons brought forth and emphasized during the discussion were: First, that it costs more to build a swing-beam than a rigid truck. Second, that freight car trucks are not watched as closely, nor given nearly the attention that passenger car trucks receive, so that there is more or less trouble from continual failures due to a large number of parts, thus making the cost of maintenance for the swing-beam truck very large, and, Third, with the improved condition of tracks the present steel trucks meet all the requirements and give good results. As no regular paper was presented at this meeting, a second subject for discussion was called for from Mr. M. N. Forney, who read an article on the "Possible Economies in Locomotives," written by himself for the American Engineer and Railroad Journal. This subject was discussed from the standpoint of economy in the simple and compound locomotives and it was evident from Mr. Forney's remarks that he has great faith that the economy of the simple engine will be considerably increased.

## A PLAN OF EDUCATION FOR RAILROAD MEN FOR SUBORDINATE POSITIONS OF RESPONSIBILITY.

After considering this subject for a number of years and studying the conditions here and abroad, Mr. Walter G. Berg, Chief Engineer of the Lehigh Valley, presented his views in a paper read before the Association of Railway Superintendents of Bridges and Buildings last month, at St. Louis. The discussion is too long to be given in detail, but the essentials are summed up as follows:

Two courses are open to boys who desire to enter railroad service. First, to enter the shops or the actual work on the road or in an office, and, second, to devote ten years to a technical education. Mr. Berg proposes a plan half way between the two. His argument is presented in three divisions.

First. A clear division should be maintained between the higher and middle classes of railroad men, and the preliminary educational systems should be kept distinct and separate from each other.

Second. The higher class, offering the material from which, as a rule, the future managers, professional men and heads of departments will be drawn, should be provided for by speciai railway departments at existing colleges, and by adding general railway subjects to the present curriculum of the technical departments of colleges.

Third. The middle class of railroad employees, comprising young men entering the railroad service in subordinate positions of all kinds, many of whom will some day fill the large number of responsible minor railroad positions of trust, should receive, after leaving the ordinary school course, a special short preliminary course adapted to the particular departmental work they expect to take up on entering a railroad shop or office. This special education will be obtained most advantageously in special railroad trade schools, to be established wherever desirable and possible throughout the country, the curriculum to consist of a one-year "Regular Course" divided into suitable departments. Further, an "Advance Course" covering a second year, for scholars who desire and have the means and qualifications necessary to continue their studies to a more advanced point.

The school would offer a regular course of one year and an advanced course of one year, also a general course. The regular course would be for boys, direct from public schools, and young men who, after a few years' work in a shop, office or railroad department, began to realize that their advancement may depend largely on a better general knowledge of some subject or specialty. The advanced course would be open to those who had completed the regular course and who desired to pursue their studies further; also to those whose previous education and railroad experience would qualify them to omit the regular course. The general course, consisting of lectures on general railroad subjects, would be open to all who desire it in order to spread a better knowledge of the general conditions, laws and public policy governing railroads among the general public. The regular course would be complete from a practical point of view and so framed as to meet the needs of practical railroad employees and would not be beyond the reach of such men. The advanced course would build upon the regular course, the subjects being extended and carried to higher grade to include laboratory, drawing-room and workshop exercises. The general course would consist of evening lectures on the most general laws and conditions governing the control, operation and management of public carriers, their relation with the state and the public, their history and influence in industrial, trade and labor questions.

The author of the paper goes into detail with regard to each course, outlining the studies and their arrangement and presents a complete programme of the work which he suggests. He says little, however, about the organization of the schools and the important question of their support, except that he believes it not difficult to provide for their endowment at import railroad centers.

## TWELVE-WHEEL WIDE-FIREBOX FREIGHT LOCOMOTIVE.

### For Burning Bituminous Slack.

### Buffalo, Rochester & Pittsburgh Ry.

This locomotive is interesting chiefly because it was designed to burn bituminous slack in a firebox extending over the rear driving wheels, the construction being such as to bring the engineer and fireman together in the same cab. The boiler is of the Player-Belpaire wagon-top type, with a sloping grate, the depth of the firebox being as great as possible over 55-in. driving wheels. The total weight is about the same as that of the Lake Shore consolidation engines, described in the American Engineer of February, 1900, page 37, but the heating surface is not as large. The B., R. & P. engine has piston valves, extended piston rods, a short front end and brake shoes behind the driving wheels. The grate area is 58.9 sq. ft. This is not large for a wide firebox engine, but it is another step toward what may be expected in general locomotive practice, a careful study of conditions of combustion with a view of building fireboxes to favor the work which they are expected to do. The combination of the Belpaire staying with a grate 6 ft. 8 ins. wide is a novelty which seems to have been worked out very nicely. In the longitudinal section it will be seen that the mud ring is unusually deep. This was done to arrange a good form of ash-pan attachment. This engine is not provided with a brick arch. It has piston valves with internal admission and marine links with short valve travel. The exhaust pipe is a new design by Mr. John Player, Mechanical Engineer of the Brooks Locomotive Works, which seems to be very successful. The following table contains additional information about the design:

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Kind of fuel to be used | Bituminous slack |
| Weight on drivers | 139,000 lbs. |
| Weight on truck | 33,000 lbs. |
| Weight, total | 172,000 lbs. |
| Weight tender, loaded | 110,000 lbs. |

**General Dimensions.**

| | |
|---|---|
| Wheel base, total, of engine | 25 ft. 8 in. |
| Wheel base, driving | 15 ft. 6 in. |
| Wheel base, total, engine and tender | 52 ft. 11⅛ in. |
| Length over all, engine | 38 ft. 8½ in. |
| Length over all, total engine and tender | 61 ft. 11½ in. |
| Height, center of boiler above rails | 9 ft. 1 in. |
| Height of stack above rails | 15 ft. 0 in. |
| Heating surface, fire box | 154.5 sq. ft. |
| Heating surface, tubes | 2,361 sq. ft. |
| Heating surface, total | 2,515.5 sq. ft. |
| Grate area | 58.9 sq. ft. |

**Wheels and Journals.**

| | |
|---|---|
| Drivers, number | Eight |
| Drivers, diameter | 55 in. |
| Drivers, material of centers | Cast steel |
| Truck wheels, diameter | 30½ in. |
| Journals, driving axle | 8½ in. by 10 in. |
| Journals, truck axle | 5½ in. by 10 in. |
| Main crank pin, size | 6¼ in. by 6 in. |
| Main coupling pin, size | 7 in. by 4¼ in. |
| Main pin, diameter wheel fit | 7⅞ in. |

**Cylinders.**

| | |
|---|---|
| Cylinders, diameter | 20 in. |
| Piston stroke | 26 in. |
| Piston rod, diameter | 4 in. |
| Main rod, length center to center | 98½ in. |
| Steam ports, length | 22 in. |
| Steam ports, width | 2 in. |
| Exhaust ports, least area | 75 in. |
| Bridge, width | 2⅝ in. |

**Valves.**

| | |
|---|---|
| Valves, kind of | Improved piston |
| Valves, greatest travel | 4 9/16 in. |
| Valves, steam lap (inside) | ⅞ in. |
| Valves, exhaust lap (outside) | Line and line |

**Valve Motion, Forward Gear.**

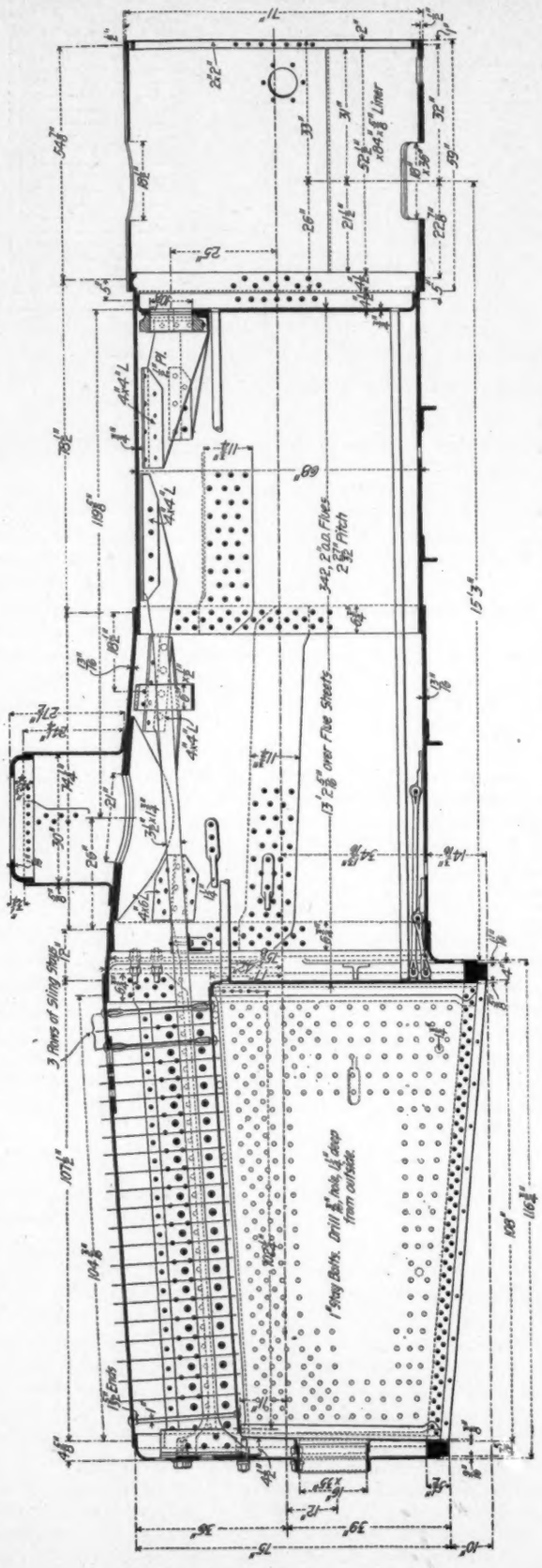
| | |
|---|---|
| Lead, full gear | —3/32 in. |
| Lead, 6 in. cut off | +3/16 in. |
| Port opening, 6 in. cut off | 7/32 in. |
| Pre-admission, 6 in. cut off | 9/16 in. |
| Exhaust opens 6 in. cut off | 17 7/16 in. |
| Cut off, full gear | 22 1/16 in. |

**Valve Motion, Backward Gear.**

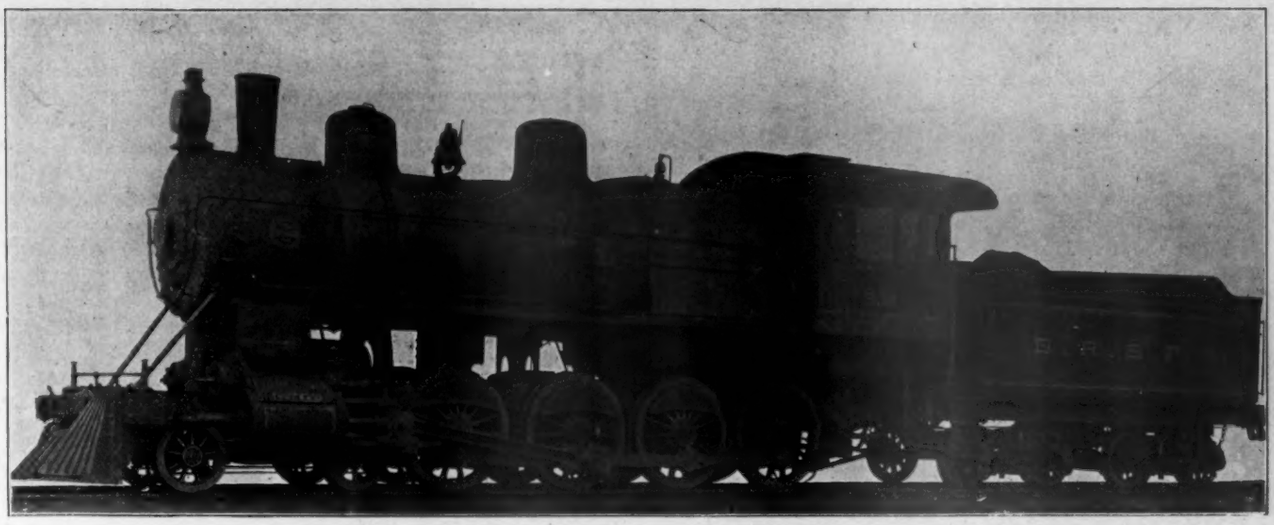
| | |
|---|---|
| Lead, full gear | +3/32 in. |
| Lead, 8 in. cut off | +13/64 in. |
| Port opening, 8 in. cut off | 21/64 in. |
| Exhaust opens 8 in. cut off | 19 in. |
| Cut off, full gear | 20⅞ in. |

**Boiler.**

| | |
|---|---|
| Boiler, type of | Player Belpaire wagon top |
| Boiler, working steam pressure | 210 lbs. |
| Boiler, material in shell | Steel |
| Boiler, thickness of material in shell | ¾ in., 13/16 in., 11/16 in., ⅝ in., 9/16 in. |
| Boiler, thickness of tube sheet | ¾ in. |
| Boiler, diameter of shell, front | 68 in. |
| Boiler, diameter of shell at throat | 78½ in. |
| Boiler, diameter at back head | 68½ in. |
| Seams, kind of horizontal | Sextuple, lap |
| Seams, kind of circumferential | Triple, lap |
| Crown sheet stayed with | Direct stays |
| Dome, diameter | 30 in. |



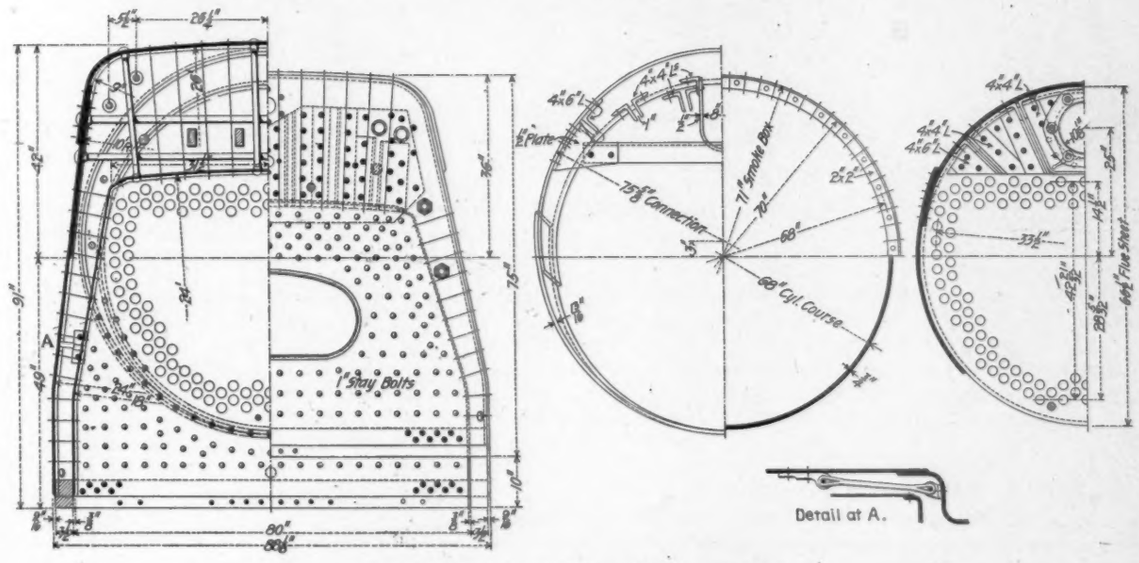

Twelve-Wheel Wide Firebox Freight Locomotive—Buffalo, Rochester & Pittsburgh Railway.



## TWELVE-WHEEL WIDE FIREBOX FREIGHT LOCOMOTIVE.

BUFFALO, ROCHESTER & PITTSBURGH RAILWAY. BROOKS LOCOMOTIVE WORKS, *Builders.*

Weights: Total of engine.....172,000 lbs.; on drivers.....139,000 lbs.; total of engine and tender.....282,000 lbs.
Wheel base: Driving.....15 ft. 6 in.; total of engine.....25 ft. 8 in.; total of engine and tender.....52 ft. 11¼ in.
Cylinders: 20 x 26 in. Wheels: Driving,.....55 in.; truck.....30½ in.; tender.....33½ in.
Boiler: Diameter.....68 in.; boiler pressure.....210 lbs.
Firebox: Length.....108 in.; width.....80 in.; depth, front.....64 in.; back.....48 in.
Grate area.....58.9 sq. ft. Tubes 342, 2 in ; 13 ft. 2 in. long.
Heating surface: Tubes.....2,361 sq. ft.; firebox.....154.5 sq. ft.; total.....2,515 sq. ft.
Tender: Eight-wheel; water capacity, 5,500 gals.; coal capacity.....12 tons.




**Sectional Views of Boiler and Firebox.**

### Fire Box.

| | |
|---|---|
| Fire box, type | Long sloping over wheels |
| Fire box, length | 108 in |
| Fire box, width | 80 in |
| Fire box, depth, front | 64 in |
| Fire box, depth, back | 48 in |
| Fire box, material | Steel |
| Fire box, thickness of sheets | Crown, ⅜ in.; tube, ⅝ in.; sides and back, ⅜ in. |
| Fire box, brick arch | None |
| Fire box, mud ring, width | Back, 3½ in.; sides, 3½ in.; front, 4 in |
| Fire box, water space at top | Back, 4½ in.; sides, 6½ in.; front, 4 in |
| Grates, kind of | Cast iron rocking, in four sections |
| Tubes, number of | 342 |
| Tubes, material | Charcoal iron |
| Tubes, outside diameter | 2 in. pitch. 2 27/32 in. centers |
| Tubes, length over tube sheets | 13 ft. 2 5/16 in |

### Smoke Box.

| | |
|---|---|
| Smoke box, diameter, outside | 71 in |
| Smoke box, length from flue sheet | 63 in. |

### Other Parts.

| | |
|---|---|
| Exhaust nozzle | Player improved |
| Exhaust nozzle, area | 24.7 sq. in. |
| Netting, wire or plate | Wire |
| Netting, size or mesh or perforation | 2½ by 2½ |
| Stack, straight or taper | Steel, taper |
| Stack, least diameter | 18 in |
| Stack, greatest diameter | 19¼ in |
| Stack, height above smoke box | 35 in. |

### Tender.

| | |
|---|---|
| Type | 8-wheel, steel frame |
| Tank, capacity for water | 5,500 gal |
| Tank, capacity for coal | 12 tons |
| Tank, material | Steel |
| Tank, thickness of sheets | 3/16 in. and ¼ in |
| Type of under frame | 10 in. steel channel |
| Type of truck | B. L. W. 100,000 lbs |
| Type of springs | Triplicate elliptic |
| Diameter of wheels | 33½ in |
| Diameter and length of journals | 5 in. by 9 in |
| Distance between centers of journals | 65 in |
| Diameter of wheel fit on axle | 6⅝ in |
| Diameter of center of axle | 5⅝ in |
| Length of tender over bumper beams | 21 ft. 1½ in |
| Length of tank | 19 ft. 6 in. |
| Width of tank | 9 ft. 10 in |
| Height of tank not including collar | 56 in |

A manhole punching machine with capacity to punch a manhole 18 by 27 ins. in size in ¾-in. plates is in use at the works of the Newport News Shipbuilding and Dry Dock Company. It is operated by hydraulic pressure of 1,500 lbs. per square inch.

## TRACK TANK WATER SCOOP.

### For High Speed Locomotives.

### Lake Shore & Michigan Southern Railway.

Among the railroads having track tanks several are making careful studies of the design of water scoops with a view of improving practice in several important particulars. Having invested in the track tanks, their use by freight as well as passenger engines is desired, which renders it necessary to take water at a wide range of speeds from about 12 to 60 and 70 miles per hour. With present designs it is difficult, if not impossible, to take water at slow speeds, and the splashing of the water at the mouth of the scoop at high speeds has been found to cut down the delivery to an extent which renders it impossible to take enough water with the present length of troughs. It has also been difficult to raise the scoops when running fast. The problems of easy elevation and of preventing splashing have been studied with special care in the design which is illustrated by the accompanying engravings, prepared from drawings received through the courtesy of Mr. H. F. Ball, Mechanical Engineer of the Lake Shore & Michigan Southern Railway. These present a design worked out by him for use on the fast passenger locomotives of that road and they will also be used in freight equipment. Mr. Ball desired to meet the following conditions:

A construction which would permit of raising the scoop at speeds as high as 70 miles per hour by hand.

One which would not require machine work on the working joints of the connections to the stationary conduit.

One which would not splash the water at the highest speeds, and

One which would permit of a power-lifting attachment in the form of a pneumatic cylinder.

There are two movable sections at the lower end of the conduit, one which embodies the dipper itself and a second one forming a connection between the dipper and the fixed conduit. To secure easy lifting at high speeds the reaction due to the thrust on the movable portions, which is caused by the water, must be made as small as possible, unless the balanced construction of the Pennsylvania design, as shown in our issue of November, 1896, is adopted. This is done in the Lake Shore design by making the lower section, which includes the mouth, as short as possible in order to reduce to a minimum the thrust of the water on the projected area of the resisting surface. Therefore, the first joint is very near the mouth of the scoop, where a slight elevation takes the cutting edge of the scoop out of the water and soon changes the angle to one which will secure the help of the water to finish withdrawing the scoop from the trough. In Fig. 1 the first movement of the lever raises the end section about its joint and when the front edge is out of the water, or soon after, the three-link chain becomes straightened and begins to lift the end of the second as well as the first section. The plate spring assists in the initial movement because it is deflected slightly in order to get the scoop down into the trough to take water. It is obvious that either hand or pneumatic power may be connected to the operating arm. Tests in service have demonstrated the ability of one man to lift it when taking water at speeds of 74 miles an hour, and there is no doubt that it can be handled by one man at 79 miles an hour, the highest speeds reached in the experiments.

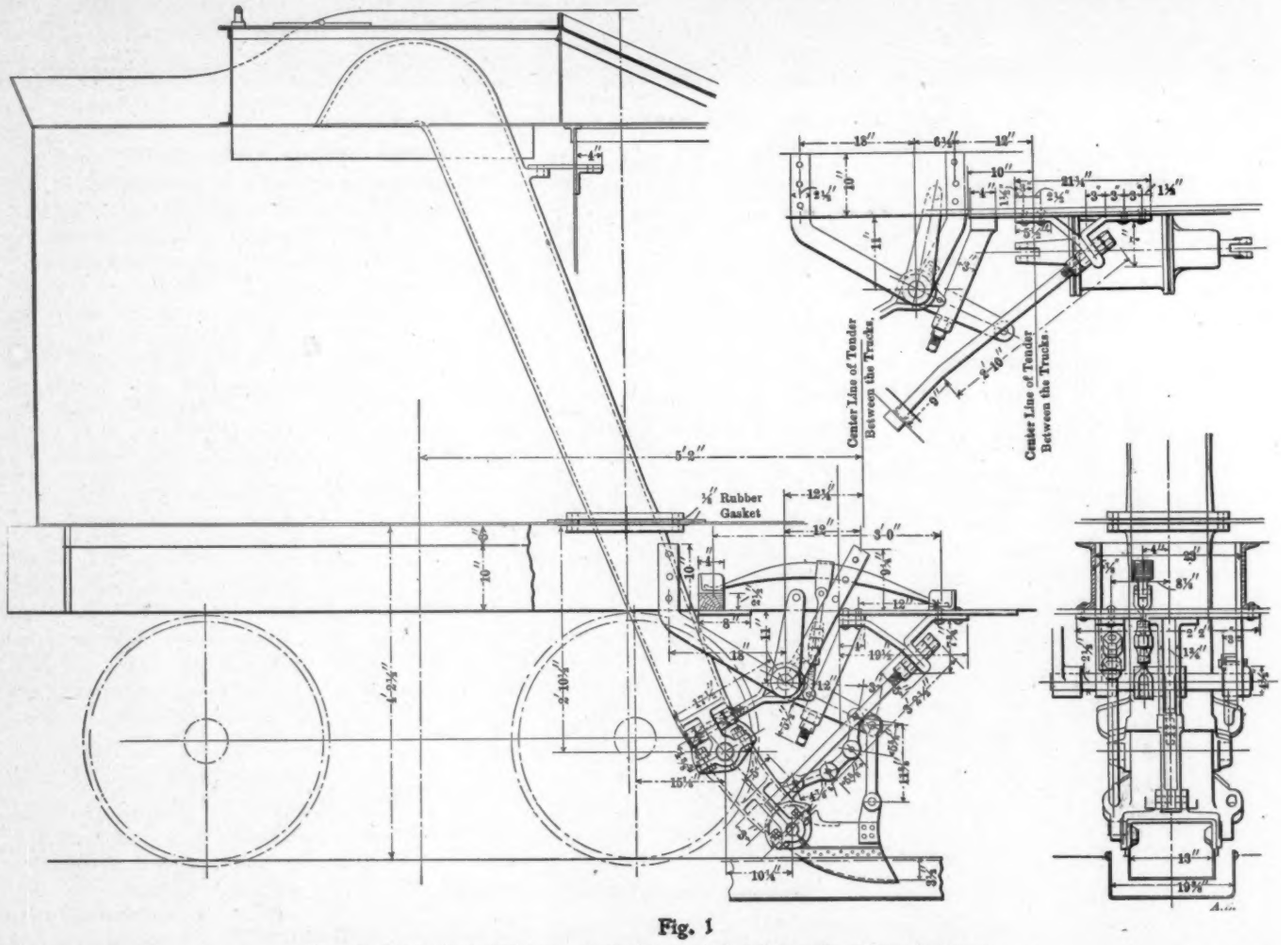



**Fig. 1**

**Track Tank Water Scoop.—Lake Shore & Michigan Southern Railway.**

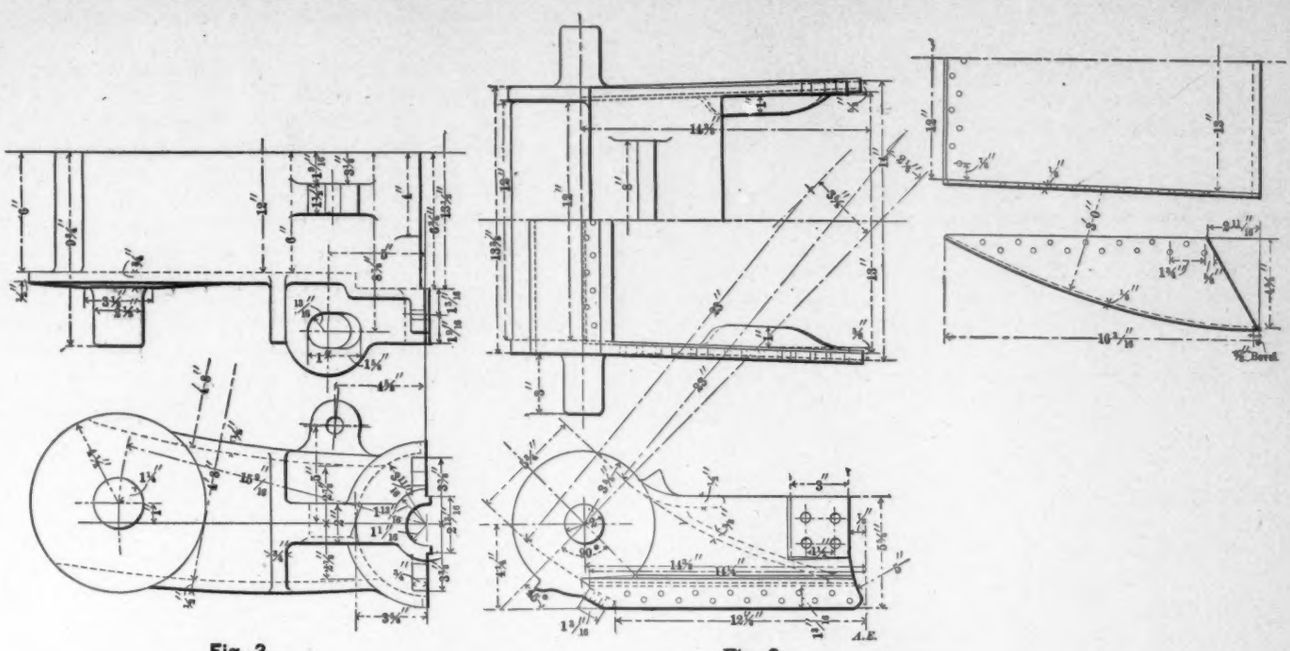


Fig. 3.

Fig. 2

**Track Tank Water Scoop.—Lake Shore & Michigan Southern Railway.**

The stationary conduit is of cast iron, ½ in. thick, jointed at the floor of the tank by a gasket joint. The mouthpiece, which is riveted to the lower movable section, Fig. 3, is of steel plate and the rest of the parts are of malleable iron with no machine finish at the water joints. The movable sections of Figs. 2 and 3 are secured at the joints by trunnions and caps, the form of the parts at the joints being such as to offer no obstruction to the water when the mouthpiece is lowered into the trough. There is no tendency to leak, because the water is handled as in a turbine water wheel, by virtue of its velocity instead of pressure.

The performance of this scoop is remarkable. Even with a dip of 4½ ins. into the water there is no difficulty in raising it, and tests carried out early in October showed it to be very satisfactory as regards splashing. In this it is in marked contrast with the comprehensive waste which usually accompanies the scooping of water at high speeds. The tests showed variation in the splashing. At 50 miles per hour there was none outside of the rail and at 79½ miles a light spray was thrown to a distance of 5 ft. 6 ins. from the outside of the rail. The following record gives the distance of the splashing from the outside of the rails:

Tests of October 9, 1900.

| Speed. | Dip of scoop. | Splash. |
|---|---|---|
| 50 | 4 in. | None. |
| 39 | 4 in | Light spray, 18 in. |
| 66 | 4 in. | Spray, 4 ft. 6 in. |
| 46 | 3½ in. | Light spray, 4 ft. 6 in., heavier at intervals of about 200 ft. |
| 70 | 3½ in. | Light spray, 3 ft. 6 in. |
| | Tests of October 10. | |
| 38 | 3½ in. | None. |
| 19 | 3½ in. | None. |
| 74 | 3½ in. | Light spray, 18 in. |
| 27 | 4½ in. | Spray 4 ft. 6 in., heavier at times. |
| 43 | 4½ in. | Same as at 27 miles. |
| 79½ | 4½ in. | Light spray, 5 ft. 6 in., heavier at times. |

The shape of the curve is such that at the mouth it is nearly tangent to a line parallel with the surface of the water, and the smallest possible amount of the surface strikes the water before the mouth is down. The construction has been made strong enough to withstand an estimated thrust of about 7,000 lbs., due to the resistance of the water. This force is roughly estimated to be necessary to exert in the form of increased drawbar pull due to taking water at 68 miles per hour. The tanks on the Lake Shore are about 1,400 ft. long and it is thought that a length of 2,400 ft. will be ample for filling tender tanks containing 6,000 gals. of water. The scoop previously in use could not be lifted at all when the speed was above 30 miles per hour, which is a good comparison with these tests to illustrate the value of the improved construction. The fact that at 50 miles per hour the ties were not wet at the rails is remarkable and exceedingly creditable to the designer.

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In reviewing the tendencies in stationary steam engine practice as illustrated at the Paris Exposition, "Power" finds the most notable things to be the absence of the "mill engine" with its rope or belt drive, all but the smaller engines being fitted with direct-connected generators. It is hardly probable that this can be accounted for on account of economy and convenience alone, but it is thought to indicate a tendency among Continental engineers toward the substitution of electrical transmission for all other methods.

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"Bumpers" in the form of mounds of earth seem to be considered the most satisfactory device for stopping cars at terminals of tracks. At the recent convention of the Association of Railway Superintendents of Bridges and Buildings the various forms of bumpers were discussed and it was evident that the development of the ideal bumper was a matter for the future. The necessary resistance for absorbing heavy shocks without involving the breakage of springs was yet to be provided, and where they were permissible simple mounds of earth were considered better than anything yet found.

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Oil fuel for locomotives on the Atchison, Topeka & Santa Fe in Southern California appears to be giving most satisfactory results, as the annual report of this road comments upon it favorably. The road has acquired oil lands at Fullerton and is pumping several wells there. A branch line 4¼ miles long has been built to reach these fields. Others have been opened up near Bakersfield and Fresno. All the engines of the San Francisco & San Joaquin Valley are being fitted up to burn oil and also the engines of the Santa Fe & Pacific running between Mojave and the Needles. It is expected that nothing but oil will be burned on locomotives of the lines of this company in California at the end of the present year.

## LARGE LOCOMOTIVE FIREBOXES.

### Their Influence on Combustion.

By A. Bement.

The most favorable size of locomotive fireboxes or, in other words, the proper amount of grate area, is a question which has forced itself before the motive power departments, especially of those roads using bituminous coal; and without doubt is the most important problem now before these officials.

When the fact is noted that in general practice grate surface has remained at about the same area for several years, while all other features of locomotives have increased enormously, the question is raised whether former grates were too

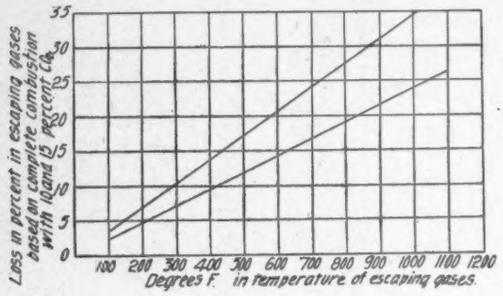


Fig. 1.

large or present ones are too small. As illustrating this matter I compare an engine of ten years ago, which is designated as No. 1, and another of more recent date, as No. 2:

| | No. 1. | No. 2. |
|---|---|---|
| Cylinders | 18.5 x 26 | 23 x 32 |
| Grate surface, square feet | 33 | 33.5 |
| Heating surface, square feet | 1,900 | 3,222 |
| Weight on drivers, in pounds | 91,000 | 208,000 |

Here is a case of one engine twice as large as the other with almost no difference in grate area. It may be assumed that

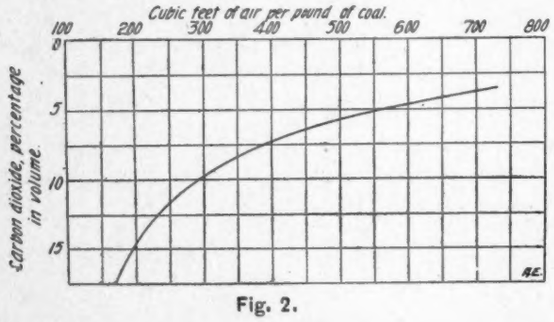


Fig. 2.

the draft-producing action of the exhaust is the same in both cases. This being true, it necessarily follows that the grate of No. 1 is too large or that of No. 2 too small. The best, most direct and least expensive way to determine this is by proper analysis of the gases and study of the combustion process, but there is other evidence at hand serving the purpose. If No. 1 grate is too large the air supply will be excessive, and the economic performance of the boiler will suffer owing to loss of energy employed in heating air not used, and passing away at the temperature of the escaping gases. This condition is illustrated by Fig. 1, where the upper curve shows the loss with an average good condition of combustion at different escaping temperatures, and the lower one with a very good combustion. It is, of course, understood that these curves are based on the supposition of all of the carbon being oxidized to $CO_2$ and none to CO, because their purpose is to illustrate the tendency of the performance of engine No. 1 provided its grate is too large. Now, if it is assumed that No. 1 grate is too large and No. 2 the right size, then engine No. 2 would show more economic performance, and more boiler horse-power owing to more coal being burned, resulting in the production of combustion gases better suited to the use of the boiler. But as the matter actually appears the tendency is for the efficiency to drop off as the size of the engine increases in proportion to the grate surface, therefore, it is evident that engines illustrated by No. 2 suffer from too small grates and from small air supply.

It would have been better had the combustion process been studied at the start, when this tendency could have been de-

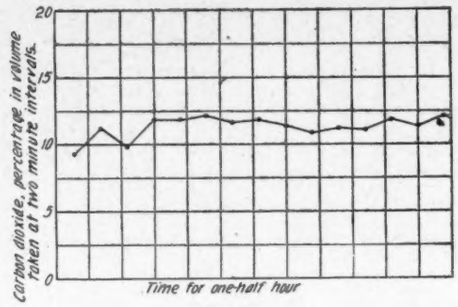


Fig. 3.

termined, rather than to have gone ahead developing a large steam-using portion of the machine without a corresponding steam-producing capacity. As it is, experience has shown what could have been determined by experiment.

I would emphasize the fact that the performance in the firebox is essentially a chemical process, and should be examined by chemical methods and means, because if the matter is so handled, and in an intelligent manner, results of great importance may always be obtained. Viewing the matter from the standpoint of the firebox it must be said that it is an apparatus for the manufacture of $CO_2$, $H_2O$ and $SO_2$, and it is important that it shall produce as large quantities of these products as possible, using the minimum amount of material. Here the work of the firebox ceases and that of the boiler begins. If the combustion is incomplete by reason of insufficient air supply the efficiency of the combination of firebox and boiler will be low owing to undeveloped heat for which the furnace, and not the boiler, is responsible. If air is present in the gases the efficiency will be low, owing to lower temperature and greater volume of gases to be cooled. This is also the fault of the furnace. The effect of increased volume is illustrated by Fig. 2.

The tendency for the gases to pass away from the boiler at a lower temperature with incomplete combustion is well illustrated by the following data:

| | A. | B. |
|---|---|---|
| Temperature of escaping gases | 643 | 633 |
| Coal, pounds per hour | 3,221 | 2,269 |
| Steam, pounds per pound of coal | 5.45 | 6.80 |

These performances were from the same boiler, same furnace and coal.

As it appears that engines with relatively small grate areas suffer from incomplete combustion, it is evident that larger air supply is required; this may be had from more grate surface, and in this line the Chicago, Burlington & Quincy and

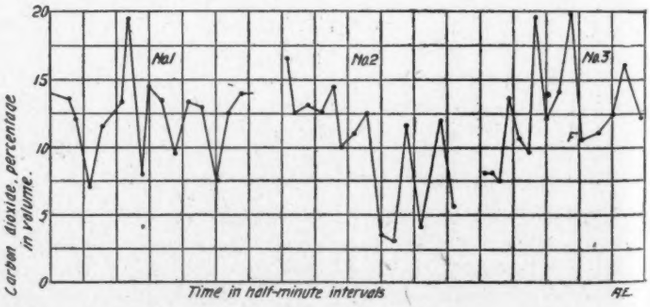


Fig. 4.

Chicago & Northwestern railways have adopted means which should be successful. I refer to the locomotives illustrated in the American Engineer, April, 1900, page 103, and August, page 237.

In addition to increased air supply, larger grate area will

allow of a greater accumulation of refuse before the fire will become seriously dirty. These are features which have to do strictly with the size of grate, but there is another which I consider important, and that is the location, which must be different from that of the small grates. When fireboxes were placed between the frames the fireman dropped coal down into a chamber; when they were placed above the frames he was afforded an opportunity for better stoking, and with the "Prairie" and "Northwestern" types there is still better opportunity for good stoking. This is a matter which I consider of the very greatest importance, and while it is, of course, acknowledged, I would say that from my experience it is much more important than is generally realized. As illustrating this point the following experiment will be of interest as showing what may be accomplished by good work.

| | |
|---|---|
| Heating surface, square feet | 3,332 |
| Furnace, hand-fired, shaking grate | |
| Grate surface, square feet | 44.6 |
| Coal, Illinois screenings | |
| Coal burned per hour, pounds | 3,221 |
| Coal burned per square foot of grate per hour, pounds | 72.2 |
| Temperature of escaping gases, F | 936 |
| $Co_2$ | 11.2 |
| O | 7.8 |
| CO | 0.2 |
| Draft in inches of water at fire | 0.35 |

This was a short experiment undertaken to illustrate the possibilities when the firemen are intelligently instructed. It will be observed that while the draft is very low, there was enough air present for considerable more coal, as shown by 7.8 per cent. oxygen. Fig. 3 shows the curve of carbon dioxide for one-half hour plotted from observations taken at two-minute intervals from an econometer. It shows a fairly uniform combustion, but if an effort had been made this curve might have been approximately a straight line, and would have reduced the very small amount of CO. This experiment is presented to indicate in a measure what should be expected from the larger locomotive grates mentioned, and this line of development should lead to a better combustion, and it may also afford oppportunity for lower pressure of blast and a freer exhaust.

Some curves from a small firebox locomotive showing the rapidly changing conditions of combustion are presented in Fig. 4. These are selected sections of curves covering longer periods of time. As will be noted, the greater number of the analyses were at one-minute intervals, but some were taken at three-quarter and half-minute periods. Nos. 1 and 2 were taken on the road, while No. 3 was from an engine on the testing plant. These curves show a most remarkable change in conditions, and it is interesting to note that the theoretical of 19 per cent. $CO_2$ is recorded three times; this condition, however, existed but for an interval probably not exceeding one second in time. Most of the drops in the curves were caused by incomplete combustion, although some were from excess of air. It is almost impossible with such rapid changes to determine the cause from the curves themselves, the latter part of No. 3, however, allows of analysis. At the time marked F the fire was coaled, which was followed by a raise to 19.5, which is slightly above the theoretical. This could only have been caused by less oxygen than the average combining with hydrogen, leaving more for carbon, and owing to more than an average amount of coal being present from which the hydrogen had been expelled. After the coaling at F the drop is to 10.5 three-quarters of a minute later. No more fuel having been supplied to the end of the curve it raises in three minutes to 16 per cent., after which it drops in one and a quarter minutes to 12, owing to excess of air.

The larger grate areas should offer the possibility of a performance midway between the two extremes illustrated by Figs. 3 and 4.

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There are 28,042 freight cars belonging to the Santa Fe System, 28,024 of which are equipped with air brakes and 27,710 with automatic couplers. The Santa Fe was one of the first roads in the United States to comply with the requirements of the Interstate Commerce Law relating to automatic couplers.

## REMARKABLE LOCOMOTIVE MILEAGE.

### 165,013 Miles Before General Repairs.

We are in receipt of the following letter, under date of October 9th, from Mr. W. C. Arp, Superintendent of Motive Power of the Vandalia Line:

"I thought it would be interesting to you to state the performance of engine 177. This engine was delivered to us in March; went into service on the 23d of the same month and was in continuous service until the month of August this year, making a total mileage of 165,013 miles without being taken into the shop for classified repairs. Had it not been that the engine was in an accident we feel safe in saying that it would have made 200,000 miles. During this time the engine lost 29 trips."

The engine, No. 177, referred to in Mr. Arp's letter is one of four 20 x 26-in. eight-wheel passenger locomotives built by the Schenectady Locomotive Works for the Vandalia Line, March, 1899. The following are the general dimensions of the engine:

| | |
|---|---|
| Cylinders | 20 by 26 in. |
| Driving wheels, diameter | 78 in. |
| Boiler steam pressure | 190 lbs. |
| Heating surface, tubes | 2,066 sq. ft. |
| Heating surface, firebox | 175 sq. ft. |
| Heating surface, total | 2,241 sq. ft. |
| Grate surface | 300 sq. ft. |
| Weight on drivers | 85,800 lbs. |
| Weight, total | 132,300 lbs. |

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The order placed with the Schenectady Locomotive Works by the New York Central & Hudson River for 20 new passenger locomotives calls for delivery between January and April of next year. The weight of these engines will be about 167,000 lbs., 95,000 lbs. of which will be on the driving wheels. They will have 21 in. by 26 in. cylinders; 79-in. driving wheels; straight boilers with charcoal-iron tubes and a working steam pressure of 200 lbs.; firebox 102 ins. long and 75 ins. wide; and a tender with a capacity of 5,000 gals. of water and 10 tons of coal. The special equipment will include Westinghouse brakes, Sansom bell ringers, National hollow brake-beams and Leach sanding devices.

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It is encouraging to note what a prominent factor the night schools are growing to be in the lives of thousands of young men who have, for various reasons, been deprived of the privileges of a complete day-school education. Noteworthy among these institutions offering such opportunities is the West Side Young Men's Christian Association of New York City, 318 West 57th street. Here the very best instruction (both elementary and advanced) is given in science, arts, modern languages, technical instruction, mathematics, music and commercial branches. Very carefully planned courses are offered in simple and advanced mechanical drawing, architectural work, also freehand and water-color instruction.

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The performance of a compressed air locomotive and power plant for coal mining service at the mines of the Susquehanna Coal Company, was recently described by Mr. J. H. Bowden before the American Institute of Mining Engineers. There are two lines of railway, one of 4,000 ft. and the other 2,100 ft., with grades varying between ½ and 2¾ per cent., the grades being in favor of the loaded cars. The locomotives were built by the H. K. Porter Company, with 7 by 14-in. cylinders, 24-in. drivers, weighing 8 tons. The air storage has a capacity of 130 cu. ft. under a pressure of 550 lbs. The locomotives work 10 hours a day, one hauling an average of 355 and the other 320 cars per day, weighing, loaded, about 5 tons each. The equipment replaced 32 mules and the entire cost of the plant is saved every 361 working days.

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In some of the brass foundries in railroad shops a large amount of brass is melted, both for bearings and other castings. The usual form of "hole in the floor" furnace is primitive and crude as compared with recent improvements. It is also expensive in the rapid wear and disintegration of the crucibles when they must be handled as much as the usual small ones are in being taken from the furnace for pouring. It is necessary that they should be small on account of the limit of weight which one or two men can carry about. The small crucibles are also wasteful in the consumption of fuel. With a crucible holding 50 pounds of brass, about 1.8 pounds will be melted per pound of coke, and the crucible will give out after 16 or 17 heats. With a modern tilting furnace, recently erected in this country, a 200-pound crucible holding about 570 pounds of metal is handled easily by one man with the aid of simple mechanism for hoisting and tipping. This new furnace gives six heats in ten hours with a loss of about 1.8 per cent., and a consumption of one pound of coke for 3.23 pounds of metal melted. The large crucibles do not suffer at all in handling, and will last for about 26 heats. This is a great improvement over the small hand crucibles, and while such a large furnace is too big for most railroad shops, the idea seems to be a good one for adaptation to such work. The saving in the cost of crucibles alone will pay for the investment. A successful design for large tilting brass furnaces, as used in a German establishment, is illustrated on another page of this issue.

## EMANCIPATION OF THE GRATES.

The widening of the grates beyond the limit of 42 ins., which has been the rule for bituminous coal-burning locomotives for many years, is believed to be the most far-reaching and most important improvement in locomotive practice since the adoption of the Stephenson link. It introduces the study of the firebox and grates with special reference to the work they must do, and it means that locomotives are to be built with reference to the fuel they use. Its effect will be seen in economies in the amount of fuel and in its cost, for qualities can now be successfully used which could not be burned on small grates because of the accumulation in the firebox. Other unquestioned advantages are the relief of the fireman and the improvement in the operation of the engine. In addition to these the wide firebox has placed the time for reaching the limits of the power capacity of the soft coal-burning locomotive far into the future, and this without involving a single new principle. In a rather wide personal consultation with motive-power officers, not one objection has been raised or a doubt expressed as to the desirability or advisability of this movement. There seems to be no reason for hesitation in adopting wide grates generally for soft coal engines, and there is every reason to believe that within a short time the number of new engines built with narrow grates will be conspicuously small, because it does not require a refined test to discover the immediate advantages of the wide grate.

Appreciation of the necessity for adapting fireboxes to the fuel was shown by Wootten when he adopted the only possible means for burning the fine sizes of anthracite. In the same way the facts that good soft coal is not always to be had and that the physical endurance of the fireman has been reached have forced the improvement. The determination of the size of grates can not become an exact science until coal becomes uniform in quality. It will require experiment and a certain amount of flexibility must be provided by means of dead plates on roads where an unlimited amount of one quality of coal is not to be depended upon. There need be no danger of getting too much grate area, because dead plates always provide means for making it smaller.

It is not only a question of amount of grate area, but of disposition. The heaviest locomotive ever built would probably be improved by making the length of grate 96 ins. instead of 132 ins., and the width 55 ins. instead of 41 ins., and it is safe to say that a decision to confine the length of locomotive grates to 8 ft. would be a wise one. Another recent design of very heavy engine of the 12-wheel type has a grate area of 37.5 sq. ft. This is large for the narrow type, but no one will question the superiority of the same area obtained with a reduction of length from 11 ft. to 8 ft. D. L. Barnes was right when he said: "No man can fire an eleven-foot grate and make a job of it unless he is a very big man."

The wide firebox brings us to an interesting stage in locomotive development, because of the intimate relation between the grates, the wheel arrangement, the height of the boiler and the length of tubes. It brings up old questions, such as the effect of decreasing the depth and increasing the length

of the "flame way," and this, if we are not misled, is to be a question of importance. In designing wide firebox engines it is considered desirable that the engine men should be kept together; at least, judging by six of the most recent designs, this is a prominent object in the minds of the designers. This should be done if other and more important advantages are not sacrificed. A well-known correspondent says: "I am satisfied that a short and wide grate will give better service than the compromises that have lately been gotten up for the purpose of providing a 'social hall' for the engineer and fireman."

There are no constructive difficulties in connection with this improvement. There is no reason to expect an increase in staybolt failures in view of the general opinion that the adoption of improved forms of extremely wide fireboxes for anthracite coal has somewhat allayed the anxiety about staybolt breakages in these boilers. The wide firebox also seems to have opened the way for material improvement in "smokeless firing." It is reasonable to expect this, and it has been remarked by several who have had opportunities to watch the operation of the new "Northwestern" type engine. The blast is lighter and it does not tear the fire, which gives promise of a reduction in spark losses. We cannot at this time think of a single point of view from which the wide firebox appears otherwise than attractive. The reasons for the delay in its adoption are probably that its need has never been felt as it is now. The opinion of such an able experimenter as D. K. Clark was unfavorable to large grates, and he has been often quoted in a way which seems unwarranted under the circumstances. The delay may be due also to this opinion.

D. K. Clark concluded from exhaustive experiments made in 1852 that, assuming throughout a constant efficiency of the fuel or proportion of water evaporated to the fuel, the evaporative performance of a locomotive boiler or the quantity of water which it was capable of evaporating per hour decreases directly as the grate area is increased: "That is to say, the larger the grate, the smaller is the evaporation of water, at the same rate of efficiency of fuel, even with the same heating surface." Clark also said: "There may be too much grate area for economical evaporation, but there cannot be too little so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions."

But Clark used coke as fuel and he did not have heavy spark-losses or the present high rates of combustion; probably these may be considered "physical conditions." It can now be said that there may be either too much or too little grate area and that the character of the fuel should govern the decision, and that Mr. Forney's rule (American Engineer, 1898, page 323) is correct, viz.: A grate should always be large enough to consume enough of the poorest fuel that is used to supply the engine with steam at critical times and places, or where it is working hardest, which is usually on grades or perhaps at points on the road where curves and grades occur simultaneously.

It is not sufficient for an engine to be capable of making schedule time under nomal conditions and in good weather. An engine may do this and still be unsatisfactory. A reasonable amount of lost time must be made up and time must be made in bad weather. Extra cars must often be handled and occasionally trains having as many as 15 cars. Railroad officers are rather rudely awakening to the fact that the latest Pullman cars weigh 62 tons and that a weight of 125,000 has been reached in cars for passenger service. The locomotive therefore needs to do more than keep pace with the ordinary increase in the demands brought about by steadily increasing traffic. If these weights are permitted to still further increase, everything tending to augment the capacity of the locomotive will soon be needed. The advent of the wide firebox is opportune and what may be expected of it is indicated elsewhere in this issue in connection with the remarkable performance of one of the new "Northwestern" engines.

## SIMPLER AND LIGHTER PASSENGER TRUCKS.

There may be some subtle reason why a truck with six wheels runs more smoothly than one with four wheels and yet it does not follow that a four-wheel truck cannot be made to carry a heavy sleeping car as smoothly as the present complicated truck of the Pullman type, which is practically the standard in use under heavy passenger equipment cars all over the country.

This truck is exceedingly heavy, a pair of them weighing nearly 40,000 lbs. It is composed of an extraordinarily large number of parts and if it must continue to be used considerable simplification should be effected. The writer has counted the number of parts up to 330, not including about 400 lbs. of bolts, in a single truck, and there may be many that were missed. This will convince anyone that it should be possible to secure the desired results in a simpler and cheaper design. That others think so, too, is apparent in the work of several motive power men upon designs of four-wheel trucks which are intended to take the place of those of six wheels under buffet and mail cars. In describing the new four-wheel truck of the Illinois Central last month the comparison in weight and cost of the two types was stated as follows:

| | Six-wheel. | Four-wheel. |
|---|---|---|
| Weight of two trucks | 36,100 lbs. | 29,900 lbs. |
| Cost of two trucks | $1,825 | $1,250 |

There can be no question as to strength when 5 by 9 in. axles are used, but there may be a difference in the riding qualities in favor of the six-wheel truck unless new methods of spring suspension are employed in the four-wheel designs. The saving promised by the four-wheel truck appears to be sufficient to warrant considerable experimental work in this direction and incidentally it will be worth while to consider steel side frames in the interest of simplicity and lightness. The fact that the ratio between the load carried and the weight of six-wheel passenger trucks is about 2 or 3 to 1, and that the same ratio in large capacity steel cars is 8 to 1, is a forcible argument in favor of an examination of the whole question of passenger truck construction, especially in view of the increasing demands upon locomotives.

The Pullman truck should have credit for the good service it has rendered. It has been so satisfactory in general as to have, until recently, escaped the notice of those who are responsible for improvements in rolling stock. It has been strengthened in the time-honored way by the addition of metal to wood until it is a question whether the wood is still needed. To break away from practice which has changed so little for so many years requires boldness and, perhaps, entirely new methods. The present outlook is, however, hopeful, and if the plans now under way are carried out the developments will be interesting, and probably exceedingly important.

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The new electric underground railway in London, running from the Bank of England to Sheperd's Bush, six miles, seems to have been greatly needed. The line was opened July 30 and in three days it was used by 260,000 passengers. The cars, locomotives and also some of the ideas of operation are American.

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The desirability of using tie plates on softwood ties and on hardwood ties on bridges upon which the track is curved was expressed at the recent meeting of the Superintendents of Bridges and Buildings. The association was practically unanimous in endorsing this practice.

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The battleship "Wisconsin" made an average speed of 17.25 knots on her official trial over a 64-mile course on October 11. The run was made in 3 hours, 56 minutes, 56 seconds, with a smooth sea and good weather. This ship was built by the Union Iron Works, San Francisco. Her length on the load water line is 368 ft., her beam is 72 ft. 2½ ins., her displacement is 11,525 tons and her horse-power 11,000.

## PERSONALS.

Mr. J. H. Fildes has been appointed General Foreman of the Lehigh Valley at South Easton, Pa.

Mr. Moses Williams has been elected President of the Fitchburg, vice Mr. E. D. Codman, resigned.

Mr. E. D. Sietz has been appointed Purchasing Agent of the Louisville & St. Louis, with headquarters at Louisville, Ky.

Mr. S. D. Kinney has been appointed Assistant Division Master Mechanic of the Chicago & Alton, at Bloomington, Ill.

Mr. John Dalman has been appointed Assistant Master Mechanic of the Pittsburg, Fort Wayne & Chicago shops, at Fort Wayne.

Mr. J. T. Goodwin, Foreman Boilermaker of the Rogers Locomotive Works, has resigned to take charge of the new boiler shops of the Richmond Locomotive Works.

Mr. Bret Harper has been appointed Mechanical and Electrical Engineer of the Detroit, Rochester, Remeo & Lake Orson, at Detroit, Mich.

Mr. W. B. Page has been appointed Master Mechanic of the Pennsylvania, with headquarters at Lambertville, N. J., vice Mr. J. L. Mohum.

Mr. F. N. Dean has been appointed Assistant Superintendent of Motive Power of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at Sioux City, Ia.

Mr. C. W. Cross has been appointed Master Mechanic of the Michigan division of the Lake Shore & Michigan Southern, with headquarters at Elkhart, Ind., vice Mr. J. O. Braddeen, resigned.

Mr. Willard A. Smith, one of the Directors of the Transportation, Civil Engineering and Army and Navy Departments of the United States Commission to the Paris Exposition, has returned to this country.

Mr. Charles M. Hogan has been promoted from the position of Road Foreman of Engines on the New York Central & Hudson River to that of Master Mechanic of the same road, with headquarters at Buffalo.

Mr. C. C. Robinson, Master Mechanic of the Peoria, Decatur & Evansville, at Mattoon, Ill., has been appointed Master Mechanic of the Illinois Central at Mattoon, the latter road having absorbed the Peoria, Decatur & Evansville.

Mr. F. R. Coates has been appointed Chief Engineer of the Chicago Great Western, vice Mr. H. Ferstrom, resigned, to become Chief Engineer of the St. Joseph & Grand Island. Mr. Coates was formerly roadmaster on the New York, New Haven & Hartford.

Mr. Oscar Antz, formerly in charge of the Car Department of the Lake Shore & Michigan Southern, at Buffalo, and a frequent contributor to the pages of this journal, has been appointed General Foreman of the Locomotive Department of the same road, with headquarters at Elkart.

W. R. Omohundro, Patent Attorney, and member of the firm of Raymond & Omohundro, Chicago, died October 11. He was 39 years old and will be mourned by many. He had a very large acquaintance among railroad mechanical and supply men.

## DRAFT GEAR—THE MOST IMPORTANT PRESENT QUESTION IN CAR CONSTRUCTION.

Those who have followed the development of the friction draft gear by Mr. George Westinghouse and have seen its accomplishments will support the belief that it is one of the most important devices introduced into car construction since the advent of the automatic brake.

Ordinary draft attachments have been outstripped by the progress in the direction of heavy cars until the troubles due to the parting of trains, it is safe to say, have become the greatest now met in the operation of trains. The increase of draft gear capacity cannot be obtained by increasing spring capacity alone, because the reaction of springs when applied directly to the cars is as destructive as the weakness of the usual types. The Westinghouse friction draft gear offers the necessary resistance with the property of gradually yielding, both in pulling and in buffing, which is indispensable in the prevention of destructive shocks. Tests carried out a few days ago near Wall on the Pennsylvania Railroad and in Pittsburgh on the Union Railway, upon cars equipped with this gear, produced results which will astonish those who have not given special attention to this device and will surprise those who have done so and who, like ourselves, have appreciated the principles involved in its construction.

The trials at Wall were made with 47 large capacity, wooden, coke cars, which have been in daily use between the Connellsville coke regions and Pittsburg for upward of two years. In this time they have seen hard service and the repairs to the draft rigging have been almost nothing. To this train was attached a heavy Pennsylvania mogul locomotive with 185 lbs. steam pressure and the engineer was amused when told that he was expected to break the train in two. Emergency stops were made at speeds of 20 and 30 miles per hour and with all the air brakes coupled up. Emergency stops were also made with 6, 12, 18 and 24 of the rear air brakes cut out, and yet in no case were objectionable shocks experienced on the rear car. A further test was made by cutting out the brakes on the 23 leading cars and, at a speed of 20 miles per hour, while the engine was rapidly accelerating the speed of the train, the rear angle cock was opened and an emergency application made on the 24 rear cars. The train was brought to a standstill with the throttle wide open, but without any damage to the draft gear. The engineer was then asked to try to break the train in two by taking slack against the ten rear cars upon which the brakes had been set by hand as hard as the brakemen could set them. Although the engineer thoroughly sanded the track in front of and back of the engine and placed the lever in full forward gear he was unable to do any damage or break the train in two by taking all the slack possible and suddenly opening the throttle. This attempt was repeated a number of times. A train of 50 cars was desired for this test, but for some reason only 47 were available.

A still more remarkable test was made a little later on 40 100,000 lbs. capacity steel ore cars belonging to the Pittsburgh, Bessemer & Lake Erie Railroad, which were coupled together on a straight and level track. To this train was attached one of the very large engines built by the Pittsburgh Locomotive Works for the Union Railroad, a part of the Carnegie System, illustrated on page 365 of our issue of November, 1898. This engine, No. 96, weighs 208,000 lbs. on the driving wheels and has 23 by 32-in. cylinders and carries 200 lbs. steam pressure. The tractive power is 53,292 lbs., this being one of the most powerful engines ever built. The hand brakes on the 10 rear cars were set as hard as the brakemen could set them and the engineer of this powerful locomotive was told to endeavor to break the train in two by taking slack against the 10 cars and pulling out as rapidly as possible. The attempt was first made without sand, but as the engine slipped sand was then copiously used, forward and back, and although the engineer tried several

times to break the train in two it was impossible to do this or to cause any damage to the draft gear.

A running test with the brakes on the first half of the train cut out and the rear brakes applied in the "emergency" was then made while the engine was accelerating the speed of the train. This test, however, proved to be less severe than the jerk test already outlined. Emergency stops were also made, but in no instance was any damage done to the draft gear. This locomotive did not slip at all when put on sand, and it evidently exerted its entire tractive force, assisted by the small amount of recoil which the friction draft gear gave.

These tests were carried out in the presence of well-known railroad officials, who remarked that should anything of the kind be attempted with the draft gear in use on their own roads, everybody concerned would be immediately taken out of the service.

It is impossible to fully appreciate the power of this engine for exerting tremendous strains on the couplings without actually having seen it under test. These tests were not made once, but a number of times and on different occasions without at any time breaking so much as a single knuckle. We, therefore, feel justified in the statement made in the first of these paragraphs. The reason no damage was done by the immense stresses imposed was that there was nothing solid to pull against. The friction gear continually yielded to the strain until its capacity was exhausted and when the stresses were removed, it may be said, the resistance yielded as gradually. The principle involved is exactly similar to that in the old illustration of the difference between breaking an object by a blow from a hammer with the object placed upon a yielding resistance and when resting upon an anvil. It is impossible to break a drawbar or anything else of the kind if, by reason of the yielding of the attachment to which it is fastened, the strain upon it cannot be made to exceed its strength.

The question naturally arises among railroad men as to the wear of these friction devices. We are assured that after three years of continuous service the wear of the friction surfaces, those described on page 149 of our issue of May, 1900, cannot be measured by a mirometer caliber.

The break in two tests exhibit but one side of the draft gear question, and while it is an important one the cost of the maintenance of cars should not be overlooked. The repairs associated with draft gear breakage amount to from 20 to 50 per cent. of the total cost of repairs to freight cars. It is not only the draft rigging itself, but also the entire end structures of cars, which are affected. These facts should be considered in connection with the increased cost of adequate draft attachments.

## INAUGURATION OF PRESIDENT PRITCHETT.

### Massachusetts Institute of Technology.

The formal inauguration of Dr. Henry S. Pritchett, former Chief of the United States Coast and Geodetic Survey, as President of the Massachusetts Institute of Technology took place on October 24th in Boston. Brief addresses were made by Senator Henry Cabot Lodge, by Colonel Thomas L. Livermore on behalf of the Corporation, and by former President Crafts. The principal feature, however, was, of course, the inaugural address of the in-coming president.

Dr. Pritchett's practical experience as director of, perhaps, the most important purely scientific branch of the Government service, rendered his inaugural address upon "The Relation of Educated Men to the State" peculiarly suggestive. He explained that for some years past as an executive officer of the general government, he had been obliged to study the graduates of colleges and of technical schools from the standpoint of their efficiency in comparison with other men rather than from the standpoint of the teacher; from the standpoint of their ability to do things rather than from the standpoint of knowing how to do things. In this capacity he had been forced to consider the relation of educated men to the government, to compare their service to it with the service rendered by others. He called attention to the fact that a constantly-growing proportion of the important places of the government are passing into the hands of college men, and he asked the question whether the training received in our institutions of higher learning merely gave men increased power or did the college life also fit men for patriotic and loyal and unselfish service to the state.

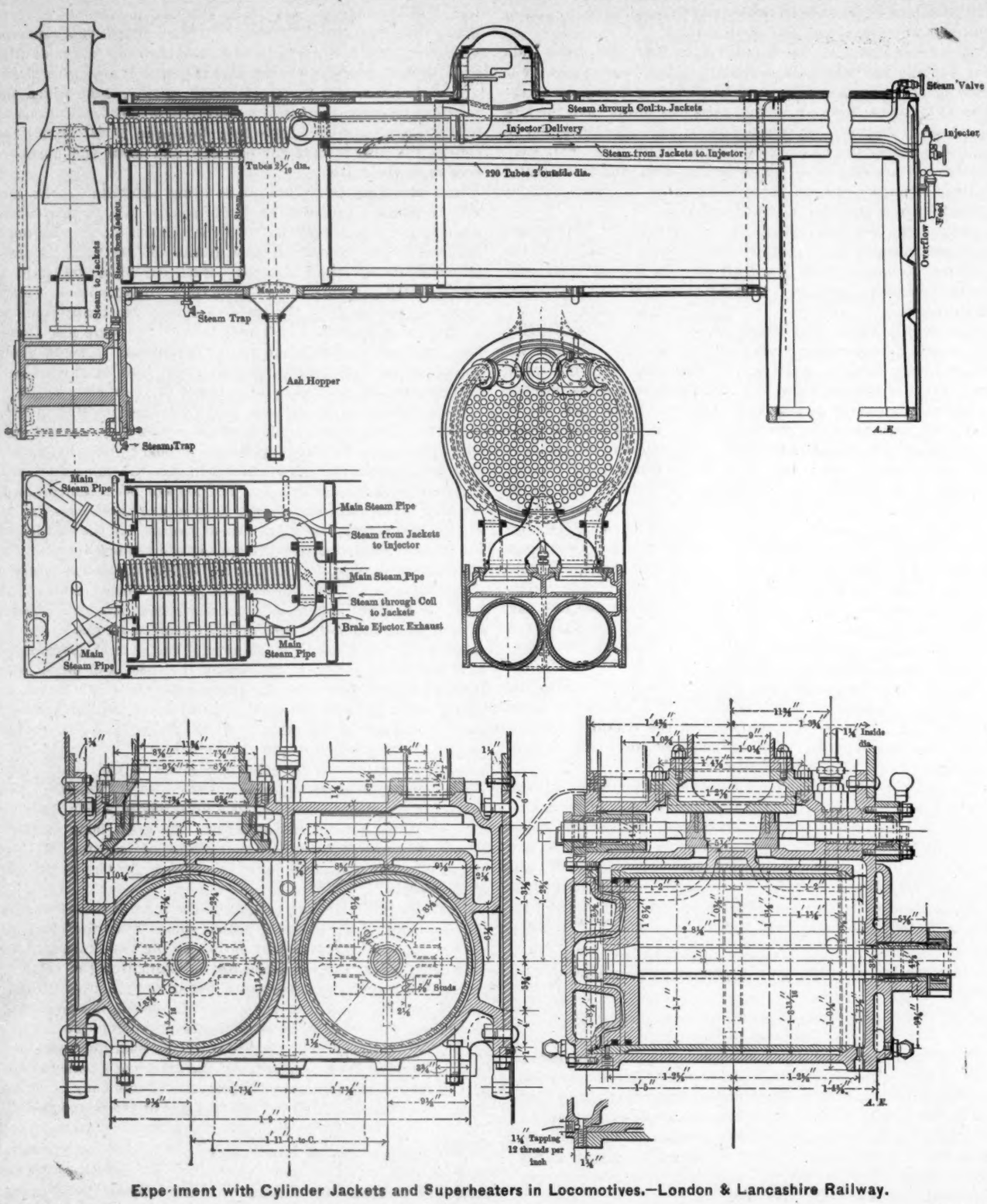
In considering this question he called attention to the fact that the state represents the whole people, that in this capacity it had given generously to higher education both through the general government in land grants and through the state governments by direct taxation. Even our older universities, like Harvard and Yale, had at some time, almost without exception, received aid from the state. Harvard was really founded by the Commonwealth of Massachusetts. The state has, therefore, the right to ask what sort of instruction is being given in our higher institutions, and to know that in these institutions men are trained in high ideals of their civic duties.

While maintaining that on the whole the institutions for higher education had justified the aid which they had received from the state, President Pritchett brought forward certain qualities of education upon which he conceived the state had a right to insist and which had not always been remembered. He said: "The state has a right to expect of those educated in a large measure by its aid a decent respect for the service of the state." He deprecated the widespread tendency to belittle government service, and to ascribe lightly the worst motives to public men. "The Government of the United States," he said, "is honestly conducted, and notwithstanding the crudeness of some legislation and the half-hearted service of a few, those who know best the machinery of the general government have a rational optimism concerning the success of democratic institutions and a wholesome respect for those who work in public service. Educated men will find in increasing numbers their best career in the state's service, and college men should be the last to misunderstand and belittle it."

Another quality of the education given to the youth upon which the state has a right to insist is its catholicity. "No system of education," said he, "is a good one in which students and graduates get out of touch with the great body of their fellow citizens. The higher institutions of learning, if they are to fill their real place, must be not only for the people but of the people."

President Pritchett then took up in the light of these remarks the character of the training which comes from the study of applied science, and called attention to the wise foresight of President Rogers and his associates in estimating the value of a scientific training, not only as a fitting for practical life but also in its development of character. In closing, as he turned to address the great body of students occupying the central portion of the great hall, they rose as one man and remained standing during the five minutes of the president's personal appeal to them. The impressive appearance of this body of young men, 1,250 strong, was one of the features of the occasion.

The aggregate sum of money spent in one year by the railroads of this country is more than many people realize. The Sante Fe informs us through its Advertising Department that that system alone has set aside more than a million dollars for improvements this fall. Two hundred thousand dollars represents the cost to that road of 300 new ballast and coal cars, of the so-called "hopper" style. By their use it is expected that gravel, crushed stone and other ballast can be placed on the track at a considerable saving in time and labor; the cars will also be used to unload coal into pits. Fourteen new dining-cars, two new composite cars, twenty passenger engines and five hundred refrigerator cars are additional important items in the list. The discarded dining-cars will be transformed into wide-vestibuled parlor, buffet and chair cars, thus materially improving those features.




Expe·iment with Cylinder Jackets and Superheaters in Locomotives.—London & Lancashire Railway.

## SUPERHEATERS AND STEAM JACKETS FOR LOCOMOTIVES.

### Experimental Application in England.

### Lancashire & Yorkshire Railway.

This road recently built twenty engines with 19 by 26 in. cylinders, all of which have steam-jacketed cylinders and one of them was fitted with a superheater. It is too soon to expect satisfactory comparison with other engines, but the experiment is likely, in due time, to bring out the value of these attachments.

To insure the proper use of the steam jackets they are made a part of the passage for the steam used in the injectors in such a way that all of the steam going to the injectors must pass through them. This also returns the water of condensation from the jackets to the boiler. The large engraving shows the arrangement of the piping. From the steam valve at the boiler-head the steam enters the jacket pipe which passes inside the boiler to the front of the engine, and in the smoke-

box it is coiled to permit it to take heat from the escaping gases. The return pipe also passes through the smokebox, as shown in the lower left-hand corner of the same engraving, and leads to the injector on the boiler-head. The jackets are formed by cylinder bushings, illustrated in the sectional drawings of the cylinders. It appears that the cylinder-heads, as well as the cylinders themselves, are jacketed.

In the engine having the superheater the boiler was shortened to give room for an unusually long smokebox to contain the superheater. This is a cylindrical shell with tube sheets at each end, having tubes slightly larger than those of the boiler, which was done to permit of drawing the boiler tubes through the superheater tubes for renewals. Sufficient space is left between the superheater shell and that of the smokebox to permit of taking the superheater out bodily when necessary to get at the boiler tubes for extensive repairs. Diaphragms are placed in the superheater in order to make the steam travel throughout its entire volume in its passage to the cylinders and the superheater tubes pass through these diaphragms. The experiment seems already to have shown that the steam is very dry, though the real value in fuel economy is not yet known.

The areas exposed to the steam in the superheater are as follows:

| | | |
|---|---|---|
| Inside of band plate | 40.63 | sq. ft. |
| End plates | 29.48 | " |
| Tubes (outside diameter) | 360.26 | " |
| Jacket coil (outside diameter) | 9.12 | " |
| Total | 439 49 | " |
| Internal surface of coil for jackets | 29.45 | " |

In discussing present locomotive practice at the recent meeting of the English Institution of Mechanical Engineers, Mr. J. A. F. Aspinall, General Manager of the Lancashire & Yorkshire Railway, mentioned this experiment as a promising one, and we are courteously permitted to present the drawings. Judging from the fact that twenty engines were fitted with jackets and but one with the superheater, we should say that probably more was expected from the former than from the latter device. We do not, however, know the views of the designer as to this.

## THE STEAM TURBINE.

### Superheating Improves Efficiency and Power.

Tests on a Le Val steam turbine at Cornell University have shown a remarkable and interesting result of superheating the steam used. Dr. Thurston records in a general way the facts in a recent issue of "Science." He finds that contrary to the usual theory of the steam turbine, a very substantial gain in economy and also in capacity is secured by superheating. This is not because of preventing "initial" or "cylinder condensation," because these phenomena are wanting in the steam turbine, wherein there are no such temperature variations as are known to cause the waste of steam in reciprocating engines. The interior surfaces of the turbine, in steady working, remain at precisely the same temperatures. Nevertheless, the gain in efficiency by superheating was found to be about 1 per cent. for each 3 degs. F. of superheating. Accompanying this was a gain of 100 per cent. in the capacity of the machine by the use of 37 degs. F. of superheat. Dr. Thurston attributes the improvement to the elimination of the friction wastes due to the retardation of the current of fluid traversing the passages of the turbine by concurrent resistances coming of the weighting of the current of steam with drops and mist and the adherence of moisture in mist, drops and even streams to the walls of the steam passages of the turbine. These phenomena will be the subject of further investigation. It is an interesting fact that the gain is substantially proportional to the degree of superheat, which is entirely different from the experience with superheat in reciprocating engines.

# CORRESPONDENCE.

## FLEXIBLE STAYBOLTS.

Pittsburgh, Pa., October 9, 1900.

To the Editor:

In your comments upon the communication of Mr. C. E. Cardew on Wehrenfennig's and Leach's staybolts, published in your October issue, you say that the experience stated by Mr. Cardew "tends to show how few things are really new." While the correctness of your view, as a general proposition, is undoubted, its expression may seem, to the general reader, to imply that the flexible staybolt of Mr. F. W. Johnstone, of the Mexican Central Railway, to which Mr. Cardew makes reference, is not "really new." Such a conclusion is not warranted by the facts, and I do not think that it was intended by your expression.

By reference of Mr. Johnstone's patent, No. 640,661, dated January 2, 1900, it will be seen that he distinctly disclaims, broadly, "a staybolt which is flexibly connected to a boiler sheet," and that his claims are limited to the form of flexible staybolt invented by him—i.e., one in which a bolt having a spherical head, and threaded at its opposite end, is combined with a plug forming an integral, closed, spherical socket, which is screwed into the outer firebox sheet. The German patent of E. Siegmeth and E. Wehrenfennig, No. 5,571 of 1878 (showing the construction of Fig. 1 of Mr. Cardew's communication), was referred to by the Patent Office in the course of the application for the Johnstone patent, and after consideration by the Examiner, was not held to be sufficient to indicate want of novelty.

The Leach staybolt, shown in Fig. 2, differs from the Johnstone in the substantial and material particular of necessarily employing an independent cap to prevent leakage. The additional expense of providing this cap and securing it in position in the bushing and the increase in the diameter of the bushing which it requires, are objections which I feel confident would prevent it from becoming a competitor of the Johnstone staybolt, even with its advantage of being free from a patent royalty.

I concur with Mr. Cardew in desiring that "honor should be given to whom honor is due," and, as it seems to me, the honor of producing the first entirely practicable and reasonably inexpensive flexible staybolt is due to Mr. F. W. Johnstone. It may not be out of place to add that I am recently informed by him that he is using six rows of his flexible staybolts in each side sheet, and two rows in the top and down the sides of the door sheet, in all new engines, and doing the same when engines are overhauled, and that in the use of these bolts on his road for eighteen months he has never found a broken one.

J. Snowden Bell.

## OPERATION OF EQUALIZERS AT HIGH SPEEDS.

To the Editor:

On page 321 of the current number of your paper I notice a letter from Mr. John Hector Graham, entitled "A Suggestion from Swiss Practice," in which the writer refers to himself as "the man who dared to say that the equalizer of locomotives was an antiquated relic which possessed no mechanical or other features to entitle it to a place upon a modern locomotive."

As stated by Mr. F. J. Cole in his excellent article on "The Equalization of Weights," published in the March and April numbers of the American Engineer, "the principal function of an equalizing lever is to equalize the weight between two or more pairs of wheels; also to allow a maximum amount of vertical motion in any one wheel in its relation to the frame of the engine, without too great a deflection of its spring or too great a variation of the load borne by that wheel. If the track is very uneven, and an engine is run over it without equalizers, each spring must in turn deflect enough to com-

pensate for its inequalities, and in doing so the load upon each spring is increased or decreased according to the amount the spring is deflected or released, and the load upon the springs belonging to the other pairs of wheels increased or decreased according to the undulation of the track. If, on the other hand, equalizing levers are introduced, the tension on the springs is uniformly maintained by the levers rocking upon their centers and preserving equal wheel loads."

In precisely what manner Mr. Graham proposes to maintain an equality of wheel loads on uneven track simply by means of a combination of helical and semi-elliptic springs, it is difficult to imagine.

The frequent, although by no means universal, absence of equalizing levers in European locomotive practice does not constitute a valid argument in favor of their abandonment in America, for the adhesive weights of foreign locomotives being much smaller than those prevailing in this country, the destructive effect on rails and bridges of sudden variations in wheel loads is proportionately diminished, and hence the necessity for equalizing levers is less urgent in Europe than it is with us.

While strongly advocating the employment of equalizers between locomotive driving springs, the following question relative to their effectiveness at high speeds suggests itself:

Assume the case of a four-coupled passenger engine having a driving-wheel base of 8 ft., and traveling at the not unusual speed of 70 miles an hour, equivalent to $\frac{5{,}280 \times 70}{60^2} = 102.67$ ft. per second.

If, now, the forward driving wheels encounter an inequality of rail surface, and their springs are thereby unduly deflected, in order to relieve this excess of load, by transferring it, either wholly or in part, to the adjacent springs before the latter are in their turn deflected by the rear drivers passing over the inequality, the inertia of the equalizing levers, etc., must be overcome, and the transfer of excess load effected in the $\frac{8}{102.67} =$ 0.078 of a second.

The question which presents itself is whether or not the levers can effect an appreciable equalization of spring tension and wheel load in so short an interval of time.

Edward L. Coster,
A. M. Am. Soc. M. E.

New York, October 18, 1900.

## C. M. HAYS TO BE NEXT PRESIDENT OF THE SOUTHERN PACIFIC RAILROAD.

Mr. C. M. Hays, General Manager of the Grand Trunk, has formally resigned from the service of that road and his appointment as President of the Southern Pacific to succeed the late Collis P. Huntington will be recommended to the directors of the Southern Pacific this week by a special committee. He was born in Rock Island, Ill., May, 1856; entered railroad service in 1873 on the Atlantic & Pacific. In 1877 he was appointed Secretary and General Manager of the Missouri Pacific. He became General Manager of the Wabash System in 1889, and four years later was elected Vice-President, from which position he resigned, to accept a very flattering offer, as General Manager of the Grand Trunk. Mr. Hays will be Operating Officer of the Southern Pacific and will have his headquarters in San Francisco. There will be little or no change in the present executive staff.

Mr. A. M. Waitt, Superintendent of Motive Power of the New York Central & Hudson River, and wife left Saturday, October 13, for California on a month's vacation, the first vacation Mr. Waitt has had in two years.

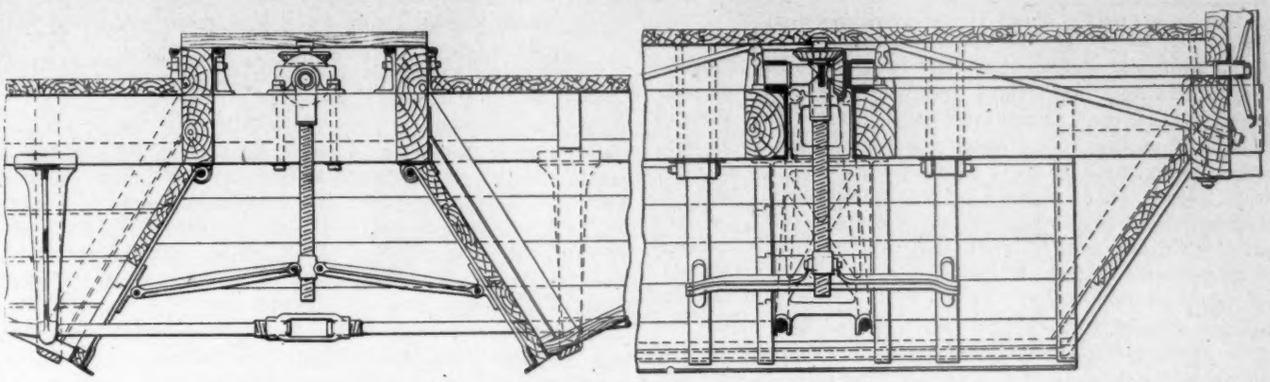
## STEEL TUBES FOR LOCOMOTIVES.

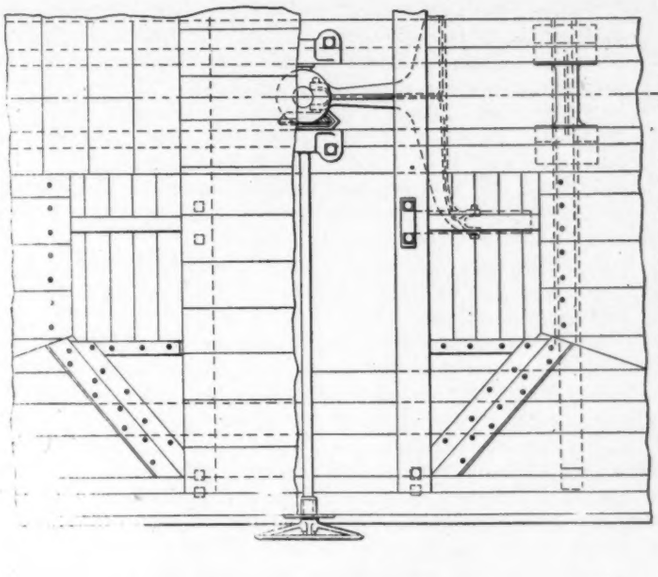
Locomotives subject their tubes to the most severe conditions to be found anywhere in steam-boiler service. Tubes need therefore to be able to meet most exacting requirements, not the least important of which is the ability to stand the repeated applications to boilers necessitated by the frequent renewals in bad-water districts. Steel, because of its homogeneity, has long been considered a desirable material for this purpose, but some of the earliest attempts to use it were not entirely successful because of faults in the material itself. A representative of this journal recently took special pains in visiting a number of prominent motive-power men to ascertain their present views with regard to steel tubes, and particularly those made by the Shelby Steel Tube Company of Cleveland, Ohio. The result was a unanimously favorable opinion, based upon severe tests in the worst water of the middle and far West, and generally with a preconceived opinion that was unfavorable because of earlier failures with tubes of steel. All of those interviewed had their more recent experience with Shelby tubes. The severity of the trials and the excellent results obtained are shown in the case of one of the roads on which a set of these tubes made 78,810 miles on one engine, after which they were applied to another and made 54,694 miles, and finally to a third, with an additional mileage of 39,893, a total of 173,397 miles. This set of tubes is now out of service, but is soon to go into another engine. Another road obtained a service of 107,000 miles with one set without removal and without having the slightest trouble to keep them tight.

These tubes are uniform in size and thickness. They are straight and homogeneous. They are drawn from solid material, without welds, and the very nature of the process of drawing insures homogeneity. The drawing process would not be applicable to anything but the best material. They are easily cut off and may be rolled quickly and are easily made tight. In one of the cases referred to, a sceptical view of steel tubes led to a number of tests by heating the ends of the tubes and plunging them into cold water, with no apparent injury to the tube, but rather an improvement by the process. This was done by a man who feared that the ends of the tubes would harden under repeated rollings, but this was shown to be a mistake. There is no difficulty in welding them. A master mechanic who has used these tubes for several years in a recent letter expresses the following opinion:

"There seems to be an idea that steel safe ends will not make a good weld with charcoal-iron tubes, but we are welding them right along and have no trouble whatever, as they make nice clean welds. I consider them superior to good charcoal-iron tubes, as they are very pliable and will stand beading and rolling better; in fact, it is impossible to crack them in beading them over. Over two years ago we put a number of cold-drawn tubes in one of our 19 by 26-in. engines and sent her to the south end of our line, where they have the worst water. After 18 months' service I brought the engine to the shop and removed all the flues except the cold-drawn ones, which were in nearly as good condition as when put in, and during this time it was not necessary to use the expander on them. This I consider a good test of the two kinds of tubes, and our experience with them has been perfectly satisfactory."

In marine service also Shelby tubes are very successful. They were fitted to the "Vamoose" two years ago and are reported by the chief engineer as being as good as when first put in. He believes that they will last four or five years longer. This testimony, added to that of the locomotive men, justify the opinion that the steel tube is a success. We have not found any evidence of the slightest difficulty with them, and there seem to be no signs of pitting.





## AN INEXPENSIVE HOPPER RIGGING.

### Made Without Machine Work.

### Central Railroad of New Jersey.

A very simple and effective hopper rigging has been designed by Mr. A. Christianson, of the Central Railroad of New Jersey, for use on double hopper-bottom coal cars of that road. The rigging is inexpensive, reliable, and finds easy application to cars where the distances from the ends of the hoppers to the center of the car are variable.

From the engraving it will be seen that the hopper doors are held up against the hoppers by toggle-arms fastened to the hinges of the doors and to a sleeve-nut which travels a 2-in. screw. This screw is hung midway between the two hoppers, from a shaft passing through suitable bearings on top of the center sills to the side of the car, by an iron casing which is allowed a swinging motion around the shaft. Power is furnished by a hand-wheel at the side of the car to drive a pair of miter-gears in connection with the screw, which is given a rotative motion and in turn imparts a vertical movement to the sleeve-nut, thus raising the toggle-arms and opening the doors to the extreme position shown by dotted lines. In the handling of large lump coal there is a tendency for the coal to bridge itself on the inside of the doors, so as to make the pressure less on one door than the other, and when this occurs the screw in opening will tend to center itself a little to one side and open one door in advance of the other. To guard against this a bracket, not shown in these drawings, has also been designed for use as a guide to the screw and bolted beneath the two center sills.

With the exception of the hinge-pins and shaft, which are wrought iron, the rigging consists of malleable iron castings so constructed as to require no machine work, but put together just as they come from the rattler. The screw is 2 in. in diameter and double threaded. The door hinges can be made of wrought iron and the jaws for the toggle-arms bolted on, or preferably made of malleable iron with these jaws cast on, as shown in the engraving. The door hangers are bolted underneath the cross tie timbers, which make it possible to place the entire hinge on the bottom side of the door and also to use a square edge plank for the first plank on the door. With this arrangement the hinge-bolts can easily be removed and the doors taken down for repairs when necessary.

The hand-wheel is used instead of a crank or wrench and is placed sufficiently close to the side of the car to be protected by the side stakes from the danger of being broken off. There are 24 small lugs cast on the inner circumference of the rim of the wheel into which fits a gravity latch shown in the drawings. The doors by this device have a close adjustment and can be locked in any desired position, placing the opening and closing perfectly under control.

The arrangement of carrying the center sills of the car by two inside truss rods and the stiffening of the side sills by needle beams and tie rods is a suggestion of good car design, but is only one of the different arrangements of under-framing to which the door rigging can be applied. Its experimental application was so satisfactory that it has been specified for a number of new 80,000-lb. coal cars.

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Switzerland has not until now been noted as a center for steel production, though her engineers have long held a high position in the mechanical world. Recently, however, a company has been formed to work the great deposits in the Bernese Oberland, where there are many million tons of ore available, averaging 50 per cent. of iron. It is intended to smelt the metal electrically, the large water power, cheaply obtainable, giving the project a reasonable prospect of success.

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The Burlington will build 10 wide firebox freight engines of the "Prairie" type and 30 more have been ordered from the Baldwin Locomotive Works. Experience with the wide firebox on this road must have been satisfactory, for the size of this order indicates a great deal of confidence in the principle. These engines will have 20 by 24-in. cylinders, 64-in. drivers and a total weight of 160,000 lbs., with 120,000 lbs. on the drivers. They are for freight service, and will run at comparatively high speeds. No surprise concerning this order will be felt by those who know of the good work of the first examples of this type. We cannot give statistics of their performance, but they are said to be able to "make steam out of anything that goes by the name of coal." There seems to be not the slightest uncertainty in the endorsement of large grates either on the "Burlington" or the "Northwestern."

## RAILROAD Y. M. C. A. CONFERENCE.

That a railroad company has more than the two functions—those of transporting freight and passengers—was demonstrated by the very enthusiastic convention of the railroad department of the Young Men's Christian Association, held at the Pennsylvania Y. M. C. A. building, Philadelphia, October 12, 13 and 14, at which 1,000 delegates from all parts of the country and from foreign parts were present. It was evident at this, the tenth international conference, that among the mechanisms of great railroads, men have been made, and that this country has given to the world in its railroad men the finest type of working men.

The opening session of the convention was held on the evening of the 12th, in the large auditorium of the building, and was filled with the enthusiasm of intelligent, earnest workers. A short testimonial meeting, conducted by C. B. Willis, Secretary of the Milwaukee department, preceded the opening session, which was called to order at 7.30 o'clock by Secretary Clarence J. Hicks, of the International Committee. Mr. Hicks presented Mr. C. E. Pugh, Vice-President of the Pennsylvania Railroad, who made the address of welcome. "It has been said," continued Mr. Pugh in his address, "that corporations are selfish, and it has even been intimated in my hearing that the Pennsylvania Railroad is grasping. However that may be, of one thing I am quite sure, it wants the best steel rails, the best bridges, the best equipment and the best men. Right in this building, within this organization, is found the machinery to turn out the men that the railroad wants, and that the railroad needs." He closed his remarks by giving the delegates a hearty welcome from the local association.

The words of welcome were responded to by A. C. Marling, Vice Chairman, in behalf of the visiting friends. Other prominent men spoke briefly. Probably the most interesting event of the day was the reception given by the Ladies' Auxiliary of the Pennsylvania Branch, to the visitors, who were received by Miss Helen Gould and Mrs. Russell Sage, both members of the Ladies' Auxiliary. In the receiving line were also Mrs. A. J. Cassatt, Mrs. Elder, C. E. Pugh, Vice-President of the Pennsylvania Railroad; Secretary C. R. Towson, of the Pennsylvania Y. M. C. A., and other earnest workers in this association. At the conclusion of the reception a substantial repast was served to the delegates.

Many prominent railroad officials of the Pennsylvania system and of other roads were present on the evening of the second day, as it was Railroad Officials' evening. In the morning a business meeting was held and in the afternoon delegates told of the benefit of noonday shop meetings. D. B. Caldwell, General Traffic Manager of the Delaware, Lackawanna & Western, read a paper entitled "The Railroad Employee as a Man." Mr. Caldwell said there was a very general erroneous impression as to the standard of character among the rank and file of railroad men on account of their environment and the nature of their work. The impression was a true one in the pioneer days of railroading when the discipline of the present day did not prevail. But to-day, when railroad construction and operation employ such a large percentage of the population of this country, all must admit that no standard of character is too high. The great interests involved call for men of capability and reliability, and no railway employee can be said to lack for incentive to make the best of himself.

Captain Green, First Vice-President of the Pennsylvania Railroad, paid high tribute to the railroad officials in his address at the evening session. The extension of this railroad work was told by delegates from Germany and Russia, and W. H. Baldwin, Jr., President of the Long Island road, also spoke.

The conference of Christian railroad men was brought to a close Sunday night after two very large meetings—one held in the afternoon and the other in the evening. Both meetings were full of impressive demonstrations.

Monday morning, the 16th, at 9.15 a. m., the delegates left the Broad Street station for Atlantic City, as the guests of the Pennsylvania Railroad.

## 6,000 STEEL CARS IN A SINGLE ORDER.

### Baltimore & Ohio Railroad.

The Pressed Steel Car Company of Pittsburg has set a high-water mark in the matter of large single orders for cars. The one in question being for 6,000 steel cars (4,000 gondolas and 2,000 self-clearing hoppers), of a carrying capacity of 100,000 lbs. each, to be delivered to the Baltimore & Ohio Railroad. Viewed from either standpoint of tonnage, capacity, or money value, the order in question is, beyond doubt, the largest ever given to a single builder before in the history of railroads.

September 28th, at a banquet at the Duquesne Club, Pittsburg, given in honor of a retiring railroad official, and at which were gathered the representative heads of all the largest manufacturing industries, mercantile establishments, and of all the high officials of the roads entering that city, Hon. J. K. Cowan, President of the Baltimore & Ohio Railroad, referred in his speech that evening to the order, as follows:

"For example, I have just concluded a contract with Mr. C. T. Schoen, President of the Pressed Steel Car Company, for 6,000 steel cars, involving the use of steel plate equivalent to that which would be required to build ten of the largest steel freight ships afloat. Four thousand of these cars will be distributed in the Pittsburg district."

The remarks quoted were made as a part of a speech relating to what the Baltimore & Ohio has done, and is doing, for Pittsburg's interests.

When Mr. C. T. Schoen was pressed for a little interesting data, he at first modestly declined, but upon further solicitation, stated: "The order is undoubtedly the largest ever given, and I would state that the Pressed Steel Car Company, in the last eight days, has taken contracts for steel cars approximating in money value nearly $7,000,000. The amount of steel needed to complete the order will amount to about 100,000 tons. And the most gratifying thing about this all is that it betokens greater things in the future, because, while our business is at present enormous, yet it may be said to be only fairly started into a healthy growth to a normal sturdy stature, as is amply evidenced by the fact that once a road buys steel cars, orders are duplicated, triplicated and quadrupled."

Besides the order mentioned the Pressed Steel Car Company has lately closed with the Union Pacific for 480 steel ballast cars of 110,000 lbs. capacity, and 300 coal cars of 100,000 lbs. capacity; as well as 300 steel cars for the Transvaal, South Africa; and an order of 75 steel cars for the Davenport & Rock Island Railway. These orders combine to make the largest single week's business ever done by any one concern in car-erecting circles.

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It is estimated that the cost of fuel per year to supply the heat lost through a square foot of unprotected surface of steam piping, such as flanges and valves, under ordinary conditions is about one dollar.

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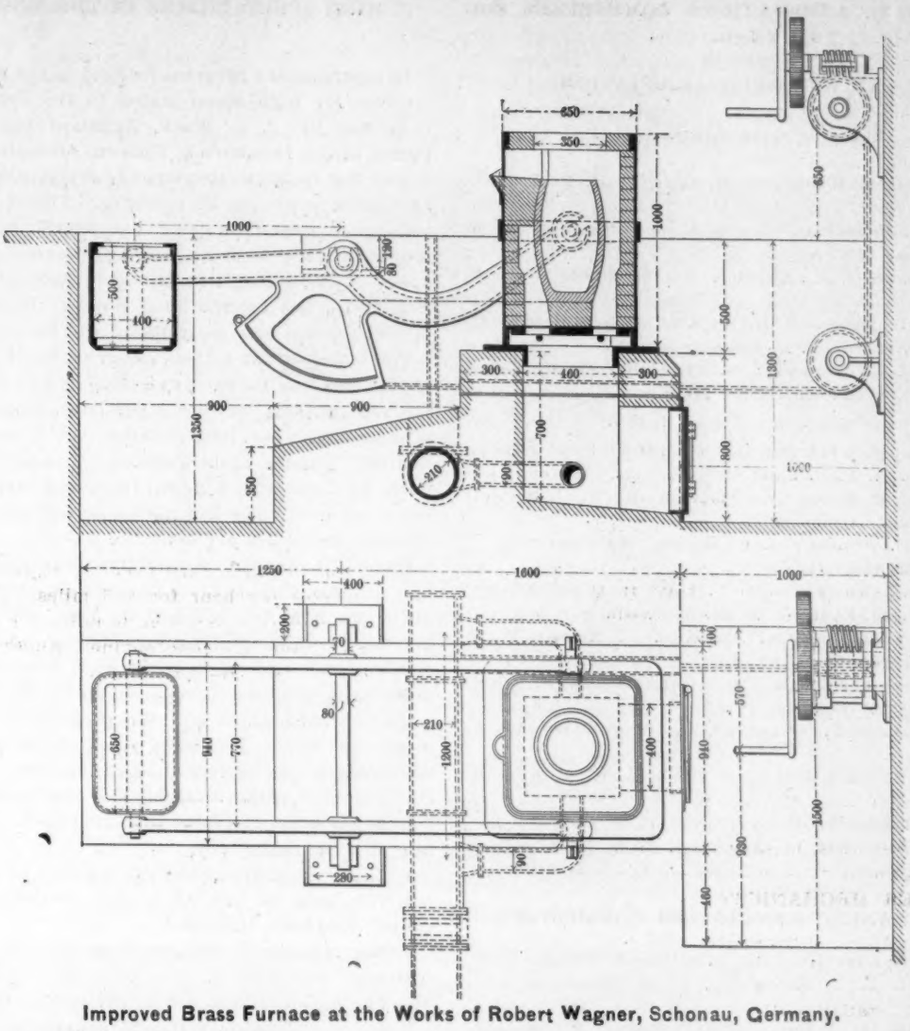
The International Railway Congress will hold its next meeting in Washington, D. C., the invitation of the American Railway Association having been accepted. The next session will be held in October, 1904, and the occasion will offer an opportunity for this country to explain its transportation problems and methods to a large number of most intelligent and progressive foreigners. It will undoubtedly lead to a better understanding of our conditions and we cannot fail to derive many benefits from the presence of so many earnest and enthusiastic railroad men in this country. Our ways of handling business will be searchingly studied and, perhaps, criticised. We should expect this and be prepared to profit by it. One feature of the visit which our supply friends will not neglect is the opportunity to acquaint foreign engineers with the admirable special equipment of all kinds which our system of railroad operation has developed.




Improved Brass Furnace at the Works of Robert Wagner, Schonau, Germany.

## IMPROVEMENT IN FURNACES FOR MELTING BRASS.

Small crucibles are generally used in this country for melting brass and their size is limited by the fact that they are handled by two men. A large number are required for heavy work and the wear and tear resulting from the handling is expensive. We are indebted to "The Foundry" for the engraving of a new brass furnace devised by Mr. Robert Wagner of Schonau, near Chemnitz, Germany. In this furnace the metal is melted in a single large crucible and is afterward poured into smaller ones, or ladles, for the moulds. This is a very compact arrangement which saves a large amount of floor space and the labor of withdrawing hot crucibles from the furnace tops is entirely avoided as this furnace is easily tipped for pouring by one man.

The crucible is held securely in a casing lined with firebrick and is elevated to an angle of about 30 degrees with the vertical by means of the chainhoist, quadrant and balance lever shown. In this position it remains stationary. The crucible is then tilted to any desired angle, for pouring into the smaller crucibles, by means of a lever which is attached to one of the trunnions arranged on each side. The crucible illustrated has a capacity of 600 lbs.

The furnace is operated with forced draught, the blast being admitted by the pipe shown in the sectional view. This pipe is 10 ins. in diameter, and supplies two branch pipes which enter the fireplace at opposite sides. In general use the blast has a pressure equal to 6 or 7 ins. of water. No chimney is necessary for the waste gases, these being passed off through a hood and pipe shown in the sectional view. By this method of construction all the heat generated below the furnace must pass over the top of the crucible. When the 600 lbs. of metal have been charged and melted, a gate shuts off the blast pipe. To keep the heat in the furnace a cover is placed on the top as soon as the charging hopper is removed, when the crucible is ready to be moved into the emptying position by the hand wheel and hoisting arrangement previously referred to.

The small crucibles into which the metal is charged hold about 100 lbs. each, and where extra hot metal is desired, they are heated just previous to being used. After all the metal has been emptied from the melting crucible some coke is supplied to the fire, the furnace is returned to its original position, the hopper is replaced and charging begins for the next heat.

Mr. Wagner says that he takes from six to ten heats a day from this furnace, thus melting from 3,600 lbs. to 6,000 lbs. of metal per day. About 200 lbs. of coke are required for each melting. The speed of melting is regulated by the amount of air forced through the furnace. For instance, a charge of 600 lbs. can be melted in from 50 minutes up to two hours, according to the air pressure. With one heat a day the fuel consumption is equal to 36 per cent. of metal melted, while with ten heats in a day of ten hours this is reduced to 20.25 per cent., thus showing quite a gain in fuel through constant operation under a high pressure of blast.

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The new express of the Northern Railway of France broke the world's record for long distance performance October 27. The train was composed of the new Compound du Bosquet locomotive and eight corridor carriages running on the Paris-Calais express schedule. According to the New York "Herald," European edition, of October 29, the distance of 185 miles was covered in 184½ minutes, allowing for one stop of 2½ minutes at Amiens, or a fraction over a mile a minute.

## M. C. B. AND M. M. ASSOCIATIONS' COMMITTEES FOR THE YEAR.

### MASTER CAR BUILDERS' ASSOCIATION.

#### Standing Committees.

Arbitration—John MacKenzie, U. N. Barr, P. H. Peck, S. P. Bush.

Supervision of Standards and Recommended Practices—A. M. Waitt, G. L. Potter, Wm. Apps.

Triple Valve Tests—G. W. Rhodes, A. W. Gibbs, R. P. C. Sanderson.

Prices in M. C. B. Rules—J. N. Barr, C. A. Schroyer, J. H. McConnell, W. E. Symons, T. B. Purves.

Tests of M. C. B. Couplers—W. W. Atterbury, W. P. Appleyard, F. A. Delano, W. S. Morris, H. Monkhouse.

#### Subjects and Committees for 1901.

Revision of Recommended Practice for 100,000 Pound Cars—Charles Lindstrom, R. P. C. Sanderson, A. G. Steinbrenner.

Uniform Sections of Siding and Flooring—R. P. C. Sanderson, W. P. Appleyard, J. S. Lentz.

Draft Gear—E. D. Bronner, G. F. Wilson, Mord Roberts, T. A. Lawes, C. M. Mendenhall.

Side Bearings and Center Plates—B. Haskell, H. M. Pflager, T. W. Demarest, J. W. Luttrell, W. H. Marshall.

Chemical Composition of Steel Axles—E. D. Nelson, F. A. Delano, C. A. Schroyer.

Cast Iron Wheels—J. N. Barr, Wm. Garstang, D. F. Crawford, J. J. Hennessey, Wm. Apps.

Index of Proceedings—F. A. Delano, D. F. Crawford, W. A. Nettleton.

Air Brake Hose Specifications—Jas. Macbeth, H. F. Ball, R. N. Durborow.

Subjects—Samuel Higgins, W. A. Nettleton, A. E. Mitchell.

Establishment of Library in connection with the American Railway Master Mechanics' Association—J. T. Chamberlain.

### MASTER MECHANICS' ASSOCIATION COMMITTEES.

Relative Merits of Cast Iron and Steel Tired Wheels—J. N. Barr, A. M. Waitt, A. L. Humphrey, H. S. Hayward, John Hickey.

Ton-Mile Statistics—H. J. Small, C. H. Quereau, W. H. Marshall.

What is the Cost of Running High Speed Passenger Trains?—G. L. Potter, F. A. Delano, George F. Wilson.

The Most Satisfactory Method of Handling, Cleaning and Setting Boiler Tubes—W. H. V. Rosing, A. E. Miller, C. H. Doebler.

What is the Most Promising Direction in Which to Effect a Reduction in Locomotive Coal Consumption?—A. E. Manchester, A. Forsyth, A. F. Stewart.

What Should be the Arrangement and Accessories of an Up-to-date Roundhouse?—Robert Quayle, V. B. Lang, D. Van Alstine.

Maximum Monthly Mileage Tnat is Practicable and Advisable to Make; How Best to Make it, Both in Passenger and Freight Service—Geo. F. Wilson, Mord Roberts, T. H. Symington.

What is the Most Approved Method for Unloading Locomotive Coal, Prior to Being Unloaded on the Tank?—William Garstang, T. S. Lloyd, W. E. Symons.

Subjects—F. D. Casanave, S. M. Vauclain, A. J. Pitkin.

Advisability of this Association Joining the International Association for Testing Materials—S. M. Vauclain, H. S. Hayward, T. W. Gentry.

Establishment of a Library in Connection With the Master Car Builders' Association—A. M. Waitt.

Index of Proceedings—F. A. Delano, S. P. Bush, C. M. Mendenhall.

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While 562 persons in the United States were killed by lightning last year, only 239 passengers were killed in railway accidents. "As likely as being struck by lightning" should be superseded by "as likely as being killed on the cars"; when comparison with an improbability is desired.—The Railway Age.

## HIGH SPEED TRAINS IN THE UNITED STATES.

In reporting the progress realized in the construction of locomotives for high speed trains to the International Railway Congress, Mr. J. R. Slack, Assistant Superintendent Motive Power of the Delaware & Hudson, presented an elaborate record of fast trains in this country representing the performance of regular trains on 22 railroads. The report is too comprehensive to permit of more than a brief notice, but it will be found valuable to those who are seeking information of this kind. It is published in full in the September number of the Bulletin of the International Railway Congress for 1900. It includes tables and diagrams of the locomotives.

The fastest of the trains classed as "light" is on the Philadelphia & Reading between Philadelphia and Jersey City, making the 90.2 miles at 58.2 miles per hour, including 7 stops. The next best (and best long distance) run is that of the New York Central "Empire State Express," making 444.6 miles at 53.9 miles per hour with 4 stops. Deducting stops, the speed is 54.3 miles per hour. The Burlington stands next with a run of 206 miles at 53.3 miles per hour and 3 stops.

Under the division of heavy trains the Philadelphia & Reading Atlantic City flyer is the fastest, its schedule being 66.6 miles per hour for 55.5 miles. The "Big Four" has a train making 266 miles at 44 miles per hour with 11 stops, and this is done with one engine. Another long engine run of 309.5 miles without change is reported on the Southern Pacific. Other trains are mentioned and the progress in the past 10 years briefly discussed. Mr. Slack sums up the progress in locomotive construction in this time as follows:

1. The later engines are heavier and more powerful;
2. Boiler pressures have increased and design and construction of boilers improved;
3. The compound engine is being used to a greater extent;
4. The area of heating surface in proportion to cylinder volume has been increased;
5. The capacity of tenders, both for coal and water, has increased;
6. The tendency is to use longer piston strokes;
7. The use of piston valves is increasing.
8. Higher piston speeds are used.

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A cost of $4.32 for driving all of the rivets, 253 in number, in a standard locomotive firebox of the Baltimore & Ohio Southwestern Railroad is a noteworthy and remarkable result. This work was recently accomplished in nine hours at a cost of 48 cents per hour, with a long-stroke pneumatic riveter made by the Chicago Pneumatic Tool Company. The same work formerly required 15 hours of hand labor, at 73 cents per hour, giving a total cost of $10.95 for hand work. If done by hand snapping, it required 12 hours and cost $7.56, at 63 cents per hour. Pneumatic tools in this case, therefore, saved $6.63 over hand riveting and $3.24 over hand snapping, the figures referring to labor charges only. This is not its only saving, because the greater rapidity of the work results in less delay in the boiler shop, and consequently increases the capacity of the shop. Because of the fact that the boiler shop is often the slowest part of locomotive plants, and also because of large amount of space required for boilers, the question of time in the boiler shop is exceedingly important.

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Our attention has been called by Mr. Geo. H. Daniels to the fact that two tickets were recently purchased at the New York Central ticket office in Rochester for Kobe, Japan, a distance of 8,833 miles. The trip requires but three changes, one at Chicago, one at San Francisco and one at Yokohama. The trip will occupy but 27 days. A short time before, the same office sold a ticket for Christ Church, New Zealand, a distance of 13,000 miles.

## CHICAGO PNEUMATIC TOOL COMPANY'S EXHIBIT.

### Paris Exposition.

This company had three separate exhibits in Paris, one at the main exposition in the Palace of Electricity and Machinery at the Champs de Mars, and another interior exhibit at Vincennes, shown in Fig. 1, and a third in the open air at Vincennes, a view of which is given in Fig. 2.

Fig. 1.—Exhibit of the Chicago Pneumatic Tool Company at Vincennes, Paris Exposition.

Fig. 2.—Full Size Section of a Steel Ship, Illustrating Use of Pneumatic Tools.
Exhibit of Chicago Pneumatic Tool Company, Paris Exposition.

All three were very elaborate and complete, and where possible the devices were shown in operation, special attention being given throughout to illustrate the machines in connection with their direct application to practical work.

The two interior exhibits in general resembled those at recent conventions of mechanical technical associations in this country, but were made much more complete because of their educational value among Europeans. The open-air exhibit at Vincennes contained much of the same machinery, but it was shown in actual service. The second engraving illustrates a full size section of a steel ship, with the keel, frames, plating and decks, by aid of which the utility of pneumatic tools in ship building was demonstrated in an impressive way. This plant was operated only during certain specified hours and it developed remarkable interest and large attendance.

In this work the fact of the applicability of one pneumatic tool to various operations was made clear, the long stroke riveter being employed in plate, deck and frame riveting, in

ship construction, and also in general work in connection with yoke frames. The rivets were heated in portable oil rivet heating furnaces, each having a capacity of 500 rivets per hour. This exterior exhibit included air compressors, cranes, plate scaling machines, drills, foundry rammers, hoists, jacks and in fact the entire catalogue of pneumatic devices for work on metal and wood, the chief features being the hammers, drills and riveters. Air was supplied by an independent compressor at each exhibit, and the large outside work also received a supply from the compressor of the exhibit of the Ingersoll-Sergeant Drill Company.

The deck and shell riveter illustrated in Fig. 3 attracted a great deal of attention, as probably one of the most important of recent improvements in ship building methods. A glance at the engravings makes the construction clear and shows the convenience of the device. A long stroke riveter is so mounted in the end of a U-section beam that it may be turned in any direction to reach a rivet. By means of an

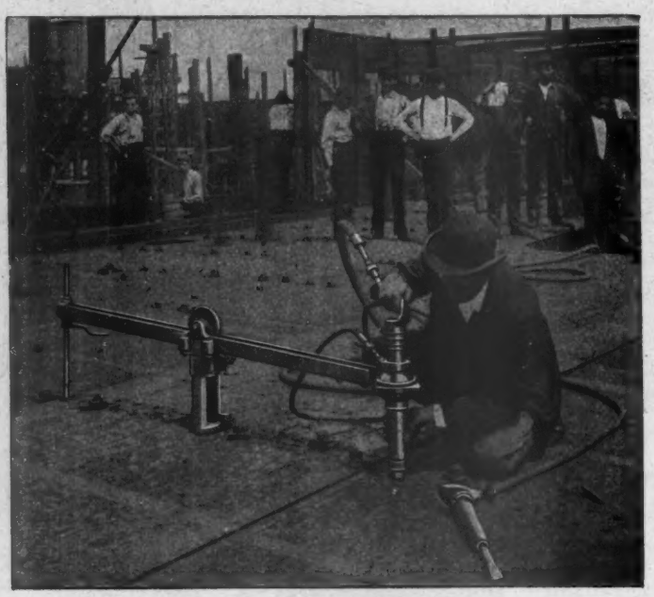

Fig. 3.—Deck Riveter.

adjustable block, the beam is clamped at the middle of its length and the end of the beam opposite the riveter has a support in the form of a rod with a number of grooves whereby an adjustable support of this end may be had by means of a latch. This device renders it easy to reach a large number of rivets with one setting of the central support. The cost is from one-half to one-third of that of hand work. It is done by ordinary labor and renders ship builders independent of riveters' unions.

Other manufacturers of pneumatic tools were also well represented at the Paris Exposition, notably the Q. & C. Company, the Standard Pneumatic Tool Company and others, those mentioned having been in competition for the official awards. The Chicago Pneumatic Tool Company received from the International Jury of Awards a gold medal, and a second gold medal was awarded to Mr. Boyer as collaborator and inventor of the tools, giving the two gold medals to this company, these being the highest awards and only gold medals awarded in this class. A silver medal was awarded to the Q. & C. Company and one of bronze to the Standard Pneumatic Tool Company, the other concerns, which are not as well known, not being in competition.

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A combined slotter and planer, the largest in the world, with a stroke of 22 ft. and a slot of the same size, is included in the equipment of the main machine shop of the Newport News Shipbuilding and Dry Dock Company, at Newport News, Va. It is driven by a 50 horse-power individual electric motor.

## CONTRACTION OF AREA.

As far as contraction of area as a measure of quality is concerned, it is more and more recognized that its value has been very much overrated. At best it is only an indication of the local condition of the metal at the point of contraction, and the best proof of its unreliability is the fact that Woehler, who is the father of contraction of area as a measure of quality, has abandoned it himself. Professor Martens, on giving official instructions as to tensile testing to all those doing any testing of railroad and other material, makes the following remarks about contraction of area: "Years of experience and very extended investigations have taught that contraction of area is an unreliable measure of quality; more so than elongation, and after some resistance on the part of the originator it was abandoned by him and the most of those who had used it."

If the originator of contraction himself abandons it as erroneous, then we can leave arguing about its value with those who cannot get out of old, time-worn ruts and superstitions.—P. Kreuzpointner, in "Sparks From The Crescent Anvil."

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The Schnectady Locomotive Works have about completed a new power house. It is 184 x 77 ft., built of brick and has two chimneys 200 ft. high.

Ten boilers of 300 horse-power each, and one 50 h.-p. engine, will furnish power for the various shops.

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Track scales are becoming more important with the general introduction of systems of tonnage rating. It is necessary to keep them in good condition and to test them often. At the recent convention of the Superintendents of Bridges and Buildings a strong argument for better scales was offered. The deck or flush scale is in most general use, but from the experience of the New York, New Haven & Hartford it appears that suspended scales with a housing may be expected to last at least twice as long as the usual construction and at the same time to be more accurate. The housed scales cost more to install and they require more room, but it was thought that their advantages were not generally appreciated or they would be more generally used. The suspended scale does not freeze, its bearings are kept cleaner and offer less friction, and if properly housed there is no deterioration from rust. The committee suggested the importance of using test cars instead of test weights, because of greater accuracy in testing when heavy loads are used. A scale which will weigh a light load correctly will not necessarily be equally accurate with heavy loads. The committee recommended the practice of private firms who test tneir scales every week.

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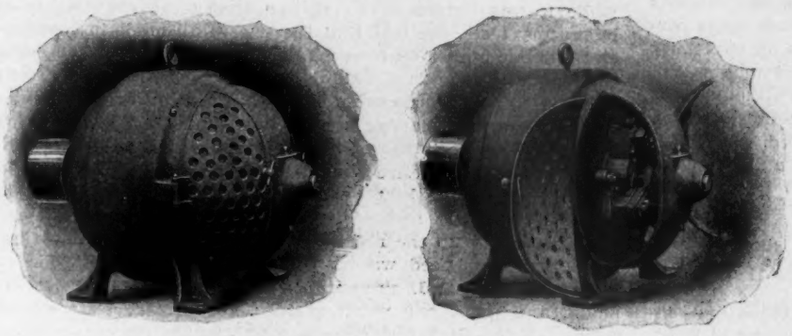
Compressed air traction seems to be making considerable headway in New York, and after the long experimental work, 28 cars having Hardie motors have been ordered for use on 28th and 29th Streets. We have recorded in our columns the earlier results of the Hardie cars on the 125th Street line, where they had a satisfactory trial for a year. The cars were afterward taken to Chicago for "owl" service at night after the cable was stopped. They were purchased for that purpose and have now been running 16 months. In New York the 28th and 29th Street lines are to be rebuilt for the air cars, and it is stated that the Metropolitan Street Railway Company will order 100 more cars similar to the 28 already mentioned when the first order has been completed. The recent consolidation of the American Air Power Company with the Compressed Air Company of New York places this work all in the hands of a single concern, the Compressed Air Company, and more active progress in air traction matters may be expected. The extent of the order from the Metropolitan Street Railway Company seems to indicate a satisfactory outlook for this branch of engineering.

## ENCLOSED MOTORS—THE TRIUMPH ELECTRIC COMPANY.

Electric motors are so generally employed for power distribution in large shops that it is natural to look to see the type which has been adopted when reading of new or rebuilt manufacturing plants and shops. Among the types which may be accepted as satisfactory are those of the Triumph Electric Company, Cincinnati, Ohio. This is one of the concerns whose estimates may be considered as guaranteeing good practice based upon sound engineering, extensive experience and reliable workmanship.



Enclosed Motors—Triumph Electric Company.

This company has recently added a number of improvements to their slow and moderate speed generators and motors. They are designed with special reference to high efficiency with regard to the magnetic circuits, the avoiding of sparking and heating, also the greatest care is observed in construction, not only in the insulation and winding, but in the machine work. All parts are made to gauges and replacements may be easily made. The enclosed motors embody all of the special features of the other Triumph machines. The poles are laminated, the armature iron clad, the brushes are of carbon and the bearings self lubricating. The engravings illustrate their appearance when open and when closed. This type was designed for use in dusty or dirty places, or where there is special danger of dust explosions. The motors may be placed on the floor, wall or ceiling; when placed on the floor a belt tightener is provided in the form of a wooden base. The doors may be wholly or partially enclosed. The covers may be perforated and the holes covered with wire gauze, as is done in the motor illustrated. This design is remarkably neat and attractive, yet the construction is such as to insure ample strength. This company makes direct-connected and belted generators, belted motors and motors for elevators and direct-driven machinery.

## THE BAUROTH GAS ENGINE.

Gas engines, while differing widely in theory of action and construction, have one common feature, that of obtaining power from the heat of the working fluid without the use of a furnace or boiler, and the many advantages of these internal combustion engines have led to their use on the larger railroads of this country, in place of steam plants, in pumping stations and are found to save annually at least 25 per cent. in cost of fuel, besides a saving in attendance.

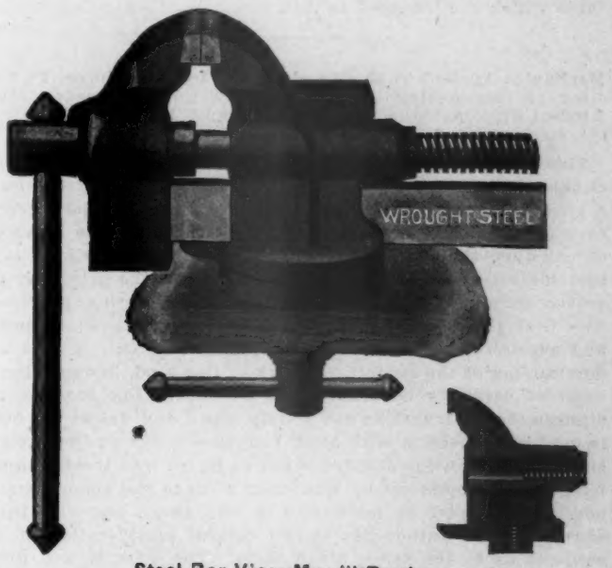
W. F. Bauroth & Bro., of Springfield, Ohio, are manufacturing a gas engine on the four-cycle principle which is designed for the greatest amount of hard service and with the fewest number of parts and is well adapted for railroad work. The bed has large bearings, while the crank-shaft and connecting rod are made of the best open-hearth steel forgings. The igniter is thoroughly positive and very simple. The time of ignition may be changed to accord with the speed, so that in starting there is no danger of having the explosions occur prematurely and consequently cause "back firing." The governor is of the pendulum type and is connected direct to the gas valve, and regulates the supply so that a full charge or none at all will be taken into the cylinder in proportion to the work being done. It is very simple and sensitive and maintains the engine at a uniform speed. The speed may be changed while the engine is in operation. There are but two principle valves, namely, the inlet valve and the exhaust valve, and these valves are of the well-known poppet type, which has always given perfect satisfaction. The pressure on the exhaust valve, due to the compression firing the charge, is relieved by the auxiliary exhaust port to such an extent that expensive and complicated mechanism for lifting the exhaust valve under pressure is done away with. By the introduction of an auxiliary exhaust port, the products of combustion are largely permitted to pass out of the cylinder without forming a crust about the exhaust valve and upon its seat. The seat is thus kept perfectly clean and bright, and consequently there is no necessity for frequent regrinding. The gas valve and gasoline pump are in line with the inlet valve, so that a perfect mixture is always assured. Either gasoline or gas may be used and the engine may be changed from one to the other while in operation.

## STEEL BAR VISE.

Manufactured by Merrill Bros., Brooklyn, N. Y.

From the wide experience of the Merrill Bros. in the manufacture of vises for use in railroad shops, that will stand the wear and tear of hard work, the steel-bar vise shown in the engraving is the outcome.

The jaws being extra heavy, cannot be broken with a hand hammer, making it an excellent chipping vise. They are faced with carefully tempered tool-steel pieces, which can be easily replaced should they become worn or injured. The wrought bar is machined perfectly square and parallel and is well fitted into the pocket in the back jaw.




Steel Bar Vice—Merrill Brothers.

It will be noticed that the plain part of the screw extends well into the back jaw, which enables the vise to be opened far enough for ordinary use before the thread is exposed. The screw is large in diameter, with a strong, square thread, well fitted into the back jaw, the threaded part (or nut) being as long as the jaws are wide.

The vise swivels on a large washer and can be turned to any position and securely held there by the bottom screw.

For straightening rods, etc., the anvil at the back will be found very useful.

## BOOKS AND PAMPHLETS.

A Hand-Book of the Electro-Magnetic Telegraph. By A. E. Loring, a Practical Telegrapher. Fourth edition, revised. Published in Van Nostrand's Science Series, by D. Van Nostrand Company, New York, 1900. Price, 50 cents.

The principles of the electro-magnetic telegraph have been presented in this little book in a very clear and concise manner for the use of practical operators and students of telegraphy. While the work does not go deeply into the subjects treated, it will nevertheless be found a great help to those who wish to take up higher and more complete works on electricity and telegraphy. The chapters on electricity and magnetism, the Morse telegraph, the duplex and quadruplex methods of telegraphy, practical telegraphy and the construction of lines, show the general character of the subjects treated. The book also contains a helpful appendix of suggestions and exercises for learners.

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Engineering Studies. Part II. Roman Stone Arches. By Charles Evans Fowler, M. Am. Soc. C. E. New York: The Engineering News Publishing Co., 1900.

This pamphlet of 16 pages contains excellent photographs of famous bridges built so long ago as to cause surprise and wonder at the engineering and scientific knowledge which their designers and builders must have possessed. They are presented as studies in engineering, the author giving a few brief paragraphs of information and comment upon each structure. The subjects are: Old Roman aqueducts, bridge of Saint Angelo, bridge of Augustus at Rimini, bridge of Alcantara, the bridge of the Rialto, the Pont du Gard at Nimes, the bridge of the Trinity, Florence, and the Canal Regio bridge at Venice. The author expresses appreciation of the skill of the builders and directs special attention to the beauty and art in these works. The pamphlet is well printed and shows good taste in every way. The reader who has not seen a collection of good photographs of these magnificent structures will spend a long time profitably in studying them. Probably the deepest impression received will be the wisdom of permanence in engineering construction and with this the desirability of combining art and beauty with strength and durability in structures which are intended to last.

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Mechanics Applied to Engineering. By John Goodman, Professor of Engineering in the Yorkshire College, Leeds. Published by Longmans, Green & Company, 39 Paternoster Row, London, 1899; 605 pages; illustrated.

This book is altogether one of the best works on applied mechanics for the use of those engineers and students who have a good understanding of the theory of mechanics and elementary mathematics, but little or no knowledge of the elements of calculus, that we have seen. The author has stated in a systematic and as concise a form as possible the principles involved in applying such knowledge to engineering problems. The first three chapters are devoted to definitions, formulae and explanatory matter, which is very essential to a good understanding of the subject. A work of this kind, in one volume, must of necessity be brief in its treatment, but in some instances the explanations are unduly short, and unless the book is used in connection with other reference books on the various subjects treated, the student is apt to be led into trouble in attempting like problems by what may seem to him correct methods. The chapter on mechanics is very short, but with these exceptions the author has shown careful consideration of his subjects as to the space given them. The book is well illustrated with 620 engravings, and many helpful notes are contained in a carefully arranged appendix. The use of calculus has been avoided as far as possible, and appears only in the chapters on Mensuration and Moments, where it is used very sparingly, and is supplemented by an elementary treatment of the operations of differentiating and integrating in the appendix, which will serve to show that a knowledge of calculus sufficient to solve practically all the problems a person is likely to come across can be acquired in less time than is spent in dodging it by round-about methods. The book will also prove useful to those preparing for examinations to the Science and Art departments and the City Guild's technical examinations, for which it was mainly designed.

"Engine Tests, Embracing the Results of Over One Hundred Feed Water Tests and Other Investigations on Various Kinds of Steam Engines, Conducted by the Author." By Geo. H. Barrus. Pages, 349; illustrated. Published by D. Van Nostrand Company, New York, 1900. Price, $4.

Those who have the book "Boiler Tests" by the same author will at once understand the purpose of the present work with the explanation that it follows the same general lines as the earlier one. Mr. Barrus has collected a very large number of engine tests made by himself under working conditions, and while it was impossible to always secure the refinements of laboratory tests, the fact that these were all made in commercial practice makes up for such deficiencies. The book is more than a mere record of figures; it also presents the author's comments and comparisons. It appears to be of special service to engineers in designing new power plants or reconstructing old ones, because it shows within rather wide limits what designs and what practice should be used and what avoided in order to secure the best results. Part I is devoted chiefly to explanations of the methods of making the tests and the manner of working up the results. It has chapters on indicating, measurement of feed water, leakage tests and calibration of instruments. Part II presents tables of tests of simple, compound and triple expansion engines, feed water tests and a review of the feed water tests with concluding chapters on valve setting and steam pipe diagrams. The latter are curious and they do not seem to follow any rule or indicate a law. The author's comments upon the effects of pressure, speed, condensing and superheating upon economy are specially interesting, and these, together with his opinions of the relative economy of the different types of engines, constitute the most valuable part of the work. In the comparisons it is made clear that the author has in all cases given due weight to the differences in the conditions which influence his opinions, and this is most important in comparisons of this character. Not the least valuable characteristic of the work is the absence of all indications of favoritism toward any particular type or condition of operation. We are glad to have it as a reference book; it is not disappointing in any particular. The simplicity of its style is commendable and we should say that steam users and prospective engine purchasers, as well as engineers, will find it exceedingly useful.

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## POOR'S MANUAL FOR 1900.

Poor's Manual for 1900 has been received and it is of unusual interest this year. The length of railroads completed on December 31, 1899, is stated to be 190,833.41 miles, traffic statistics and earnings being given for 184,178 miles. During the year 1899, 3,981.36 miles were built. The introduction opens with a general exhibit for the fiscal year 1899, including comparative figures for a number of years. Previous volumes of this collossal work have included valuable discussions of statistical subjects, but we have not seen anywhere such a comprehensive review of the progress of railroads as the editor presents in this introduction in the form of an 89-page chapter, entitled "A Study in Railway Statistics." It follows the tables with which the record is brought up to date. This is a review of the statistics of development and finances of the railroads of the United States, with special reference to the period from 1880 to 1899. This review is particularly appropriate at the approaching end of the century in view of the wonderful development of the resources of this country. Brief notes will serve to indicate the character of this masterly review.

In 1826 steam was first applied on the Stockton & Darlington Railway. In 1840 there was in New England a well-defined system of railroads. A number of tables give the location and mileage of all the roads in operation in various sections of the country at that time. The recognition of the superiority of rail over highway transportation immediately resulted in a large number of schemes which were fostered under our peculiar political organization, but up to 1848 progress in construction was slow, although it absorbed all of the floating capital of the country. The discovery of gold in California led to the first great movement in railroad construction and its effect upon industry and commerce was prodigious. It was without precedent in history. Up to 1848, 5,996 miles had been completed, and in 1860 it had reached 30,635 miles, an increase of 400 per cent. Lake Erie was next reached and

lines pushed on to Chicago in 1853. In 1847 the Pennsylvania Railroad began, and was opened in 1854. Tables give the terminal points and lengths of the first road built in each State, and the date of opening. During the civil war, mileage fell off considerably. The resumption of specie payment in 1879 gave an impulse to railroad construction never before experienced anywhere in the world. Mileage increased from 93,262 in 1880 to 166,654 in 1890, an increase of 80 per cent. The Union Pacific was completed in 1869, which was also the date of the beginning of construction of the Northern Pacific and the opening of an important period. Railroad construction has proceeded in great waves and in recurring periods it became the absorbing passion of the people. There are discussed by the editor also the subjects of consolidations, systems, formation of trunk lines, capitalization and finance. One needs to study this discussion in order to appreciate the influence of our railroads; we can give but a fragmentary review of such a work.

The most important new feature introduced into the Manual in recent years is one first presented in this year's edition and is entitled a "Ready Reference Bond List," and covers 86 pages of the Manual—from 1296 to 1381, inclusive. Its distinctive features are, (1) showing amount of annual charge on each issue; (2) arrangement of dates of interest payments, which in addition to giving for each separate road the usual data, enables a bond clerk to run down any column, say that headed "JJ," and ascertain at once all railroad coupons that fall due on the first of January or July; (3) "Property Covered," giving the terminal points and mileage of the lines covered by each separate mortgage, together with the average amount (in dollars) of bonds outstanding per mile of railroad, and (4) the names and addresses of the Trustees for each mortgage.

The Manual for 1900 covers 1954 pages, of which 987 pages are devoted to the presentation of the statements of 2,026 steam railroad companies; 209 pages are devoted to the statements of 1,132 street railroads and traction companies; 84 pages are devoted to the statements of 166 leading Industrial Corporations, and 132 pages are taken up with the Department of State, City and County Debts, covering the affairs of 367 corporations.

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Interstate Commerce Commission.—The proceedings of the twelfth annual convention of Railroad Commissioners, held at the Pfister Hotel, Milwaukee, Wis., May 28 and 29, 1900. Bound in cloth.

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Data for Designing Bridges.—Messrs. Waddell & Hedrick, Kansas City, Mo., have issued a little pamphlet which puts in convenient form the data required to make the best and most economical design for railway bridges and trestles. It will be found useful to railroad men who have occasion to make contracts for such structures. After each question are blank lines for convenience in filling in the desired information. Copies of this pamphlet can be obtained by addressing the office of that firm.

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Souvenir of the Victoria Bridge.—The Grand Trunk Railway has prepared a handsome and appropriate souvenir of the Victoria Jubilee Bridge across the St. Lawrence River at Montreal which was opened for traffic December 13, 1898. The new structure was found necessary to take the place of the famous old Victoria Tubular Bridge, which was put into service in 1859, and with the new structure the capacity for traffic of the Grand Trunk at this point is enormously increased. It is interesting to note that the old bridge was 16 ft. wide and 16 ft. high, with but a single track. The new one is 66 ft. wide and from 40 to 60 ft. high. It has double track, roadways and footways and cost but $2,000,000, as against $7,000,000 for the original structure. The souvenir is handsomely illustrated, well printed and bound in hinged aluminum covers. It is a fitting record of this interesting structure. We presume it was prepared under the direction of Mr. W. E. Davis, Passenger Traffic Manager of the road, to whom we are indebted for a copy.

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Ball Bearings.—The Ball Bearing Company, of Boston, Mass., have just sent a new issue of their twentieth century catalogue of ball and roller bearings for all kinds of machine construction, shafting and vehicles. This book illustrates in addition to their ball thrust collar bearings, hub patent thrust collar bearings, grooved ball end thrust bearings, thrust collar roller bearings and grooved ball shaft bearings, their large variety of ball bearings for light and heavy vehicles, swivel axles and bearings for automobiles. It also contains tables of sizes and maximum loads for each style of bearing, together with a list of prices. This catalogue can be had by addressing the main office of this company at Watson Street, Boston, Mass.

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The life of crucibles used for melting brass is usually short. The service is severe and only the best of them will last more than a comparatively short time. Our attention has been attracted to the fact that a graphite crucible was recently used at the foundry of the Magnus Metal Company for 34 heats, when it became too thin for further use, but up to that number of heats it had not cracked. Another example of long use occurred recently at the works of Pattin Brothers & Co., Marietta, Ohio, where a crucible went through 42 heats. These were Dixon graphite crucibles made by the Dixon Crucible Company, Jersey City, N. J. Mr. George Couter, foreman of the brass foundry of the Kansas City, Pittsburg & Gulf Railroad, describes a still better experience. He says: "I have a Dixon crucible from which I have taken 45 heats of phosphor bronze. It is a No. 50 crucible and the furnace has natural draft. In the last heat I melted 140 lbs. There are no cracks in it. I am afraid to use it again on account of its being thin."

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Mathematical and Surveying Instruments.—Keuffel & Esser Co., New York, has just issued their new catalogue of drawing materials, mathematical and surveying instruments. This new edition is considerably enlarged. The descriptive matter has been elaborated and made more complete, many cuts have been added and others replaced by better ones. Of the several additions to this book we notice a greatly improved assortment of slide rules, new planimeters and pantographs, which are now listed in a heretofore unattempted manner. Fine narrow steel tapes are shown in an increased variety, with the reels listed separately to allow of greater latitude in selecting. Current meters, hook gauges, tide gauges, aneroids, barographs, thermographs and hygrographs have been added, and of sextants and octants there is a new list. The assortment of drawing instruments, scales, drawing tables, etc., has been considerably enlarged and profile and cross-section rulings on cloth have been added, thus making this catalogue of mathematical and surveying instruments one of the most complete that we have seen.

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Pan-American Exposition.—Up to the present time the descriptive matter bearing directly on the Pan-American Exposition has been confined to certain features of the Exposition, as they have been developed. The booklet which has just been issued by the Bureau of Publicity of the Pan-American Exposition gives a very comprehensive idea of the character of the Exposition, which is to celebrate the achievements of civilization in the past 100 years of development in this hemisphere. The 20 or more structures which will surround 33 acres of court settings will be for the exhibits brought together from all parts of the Western Hemisphere and from the island possessions of the United States. The exhibits of other countries will, of course, not be included, as the Exhibition is for all Americas, as the prefix Pan means. The total cost of the Exposition, exclusive of exhibits, is now estimated at $10,000,000. Of this amount about $3,000,000 will be expended upon the Midway. The sum for the Midway is more than the total cost of some very pretentious expositions, so that by comparison one may gain a very fair idea of the work which Buffalo is carrying rapidly to completion. A beautiful landscape comprising 350 acres, half a mile wide and a mile and a quarter long, is devoted to this wonderful enterprise. The gates of the Exposition will be opened from May 1 to November 1, 1901, and Buffalo, a very delightful city of nearly 400,000 population, with its nearness to Niagara Falls, where unlimited electric power may be had for decorative purposes, will attract millions of people next year and outshine all former undertakings of this nature.

The Joseph Dixon Crucible Company, Jersey City, N. J., have issued a folder concerning the remarkable durability of their silica graphite paint. A photograph is shown of the Park Street bridge of the Cleveland, Cincinnati, Chicago & St. Louis Railway at Cincinnati, Ohio, the girders of which are exposed to the fumes and smoke of 500 locomotives every day. It was painted with Dixon's silica-graphite paint five years ago and the action of the fumes have been successfully resisted for this long period. The folder also contains a statement from Mr. J. Y. Hill, Roadmaster of the Southern Railway, made before the Association of Railway Superintendents of Bridges and Buildings, expressing satisfaction with the covering qualities and appearance of this paint. The company invites correspondence with reference to time records in all climates.

## EQUIPMENT AND MANUFACTURING NOTES.

Berry Brothers, of Detroit, believed to be the largest manufacturers of varnish in the world, have decided to enter the railroad field and develop that branch of their business systematically.

The Standard Steel Platform is now in use on one hundred railroads throughout the United States, Canada and Mexico, which shows a very steady and remarkable growth in popularity since its first introduction to the railroads in 1897.

The Rand Drill Co. has removed its main office from 100 Broadway, New York, to the fifteenth floor of the new building just erected by the American Exchange National Bank, at 128 Broadway, corner of Cedar Street, to which place all future correspondence should be addressed. In its new office, the company will occupy the entire floor, in conjunction with its allied interests, the Pneumatic Engineering Co., the Rendrock Powder Co. and the Davis Calyx Drill Co.

Pneumatic hammers are gaining ground rapidly in their application to riveting. The Riter-Conley Manufacturing Company are using the long-stroke 13/16 by 9-in. riveting hammer of the Chicago Pneumatic Tool Company at the Laughlin Furnace, Pittsburg, with effective results in very difficult service. They rivet three 1-inch plates with 1⅛-inch rivets, and with hand work the ratio of loose rivets was 4 in 12, while the pneumatic riveter drives them four times as fast and with a ratio of one loose one in 18, a remarkable performance under the circumstances.

Mr. E. H. Talbot, formerly Editor and Proprietor of the "Railway Age," has established a bureau in Mexico for the benefit of American interests. The business is conducted under the firm name of Talbot & McCauley. It includes a permanent exhibition of American products, salesroom and information bureau. Mexican investments and business interests, government concessions and contracts will be negotiated. Mr. Talbot's wide acquaintance in both countries should make this a profitable and successful undertaking. The offices and permanent exhibition rooms are in the Centro Mercantil Building, City of Mexico, facing the National Palace.

At the national convention of Railroad Commissioners held at Milwaukee some very interesting reports from the various committees that had been appointed the year previous were presented and adopted. Among them were papers on "Classification and Construction Expenses of Steam Railroads," "Delays Attendant Upon Enforcing Orders of Railroad Commissioners," "Legislation," "Uniform Classification" and a very important report on "Safety Appliances." In this paper some excellent recommendations were made which were adopted by the convention. The question of car lighting was dealt with in a report as follows: "The Pintsch gas light system is another improvement rapidly coming into general use. Its great advantages are most highly appreciated by the public, and its adoption, wherever practicable, should be required."

The award to the Triumph Electric Co., manufacturers of electric light and power machinery, Cincinnati, Ohio, of a medal at the Paris Exposition for their well-known machines, came as a complete surprise to them, for they were not direct exhibitors at the Exposition. Their machines on exhibition there were loaned to the Fay & Egan Co., the Ferracute Machine Co. and the R. K. Le Blond Co. for operating their exhibits. The Triumph Electric Co. were not competing for a medal, not being direct exhibitors, and of course they naturally feel highly complimented that the machines attracted so much attention.

The preservation of wood from rotting and decay has occupied the attention of engineers for many years. A number of well-known processes have been developed and used long enough to show the possibilities in this direction, but the cost of their application has always been a serious obstacle. Our attention has been drawn to what is known as Royal Wood Preserving Oil, a preservative for which excellent results are reported and one which is applied externally with a brush, the consistency and specific gravity of the liquid being such that it rapidly permeates the fiber. This preserver, while not closing up the pores of the wood, appears to act in such a way as to exclude air and moisture. It also has antiseptic properties, whereby the albuminous parts of the wood are coagulated and the germs of decay and fungus growth are destroyed. It is stated that wood treated with this preserver is also protected from the toredo worm. The effect of the preservative upon the wood itself is to give it increased resistance against wear and tear, warping and shrinking. Its covering properties are as follows: One gallon will cover 300 sq. ft. of dressed lumber, 250 sq. ft. of rough lumber, 100 sq. ft. of shingle roof and a second coat if necessary requires but one-fourth of these quantities. It seems to be specially well adapted to stock, refrigerator and flat cars; railroad ties and trestles, bridge timbers and piling, telegraph poles and cross arms; boats, barges and wharves; tanks, windmill towers and derricks and for all purposes requiring the use of wood below ground, or in other locations having poor ventilation. The material is manufactured and sold by the Royal Wood Preserver Company, 5 South Levee, St. Louis, Mo.

Early in October the writer thoroughly enjoyed the view along the Susquehanna from the observation platform of the "Black Diamond Express" of the Lehigh Valley Railroad, and those who have not taken this trip across Pennsylvania on this train are advised to do so. This is one of the trains which gives this country its reputation for comfort, elegance and luxury in traveling and the scenery justifies all that has been said of it. There is scarcely an uninteresting mile between Buffalo and the New Jersey flats. The passenger department, under the direction of Mr. Charles S. Lee, General Passenger Agent, has devised a tasteful and artistic brochure, entitled the Lehigh Valley Railroad as Seen from the Train. Copies are handed to passengers and brief paragraphs of information about the country and places passed contribute to the interest of the trip. There are few things left to be desired in traveling on the best of American railroads, and even the chronic grumbler is practically disarmed. To this result the passenger departments have contributed a most important part. They have been largely instrumental in bringing about the present high standard of passenger-train equipment and the development, to a principle, of punctuality, believing that the effect of these factors is to increase patronage by producing satisfactory service and satisfied travelers.

The Rock Island arsenal is to have one of the finest machine shops in the country when the proposed extensions are completed. Specifications and proposal blanks have just been issued for the largest number of machine tools ever purchased at one time in this country. The list embodies 531 items and almost all items include a number of tools. Some of the various machines called for are 218 lathes, almost all of which are to be provided with chucks and various attachments. There are 325 milling machines called for, one item alone calling for 240 machines. A lot of 60 drill presses of various sizes includes an item for 23 three-spindle drills; another for 15 two-spindle presses, and one is for 12 single-spindle machines. The largest single lot called for takes in 83 two-spindle machines, with a working surface of 12 by 15 ins. Of presses there will be 22, this number including almost every type of metal press built. The item of drop hammers alone will run over $50,000, as there are 63 of them called for. They range from 100-pound to 1,500-pound sizes. A great many other items are called for, including machines and machinist tools.